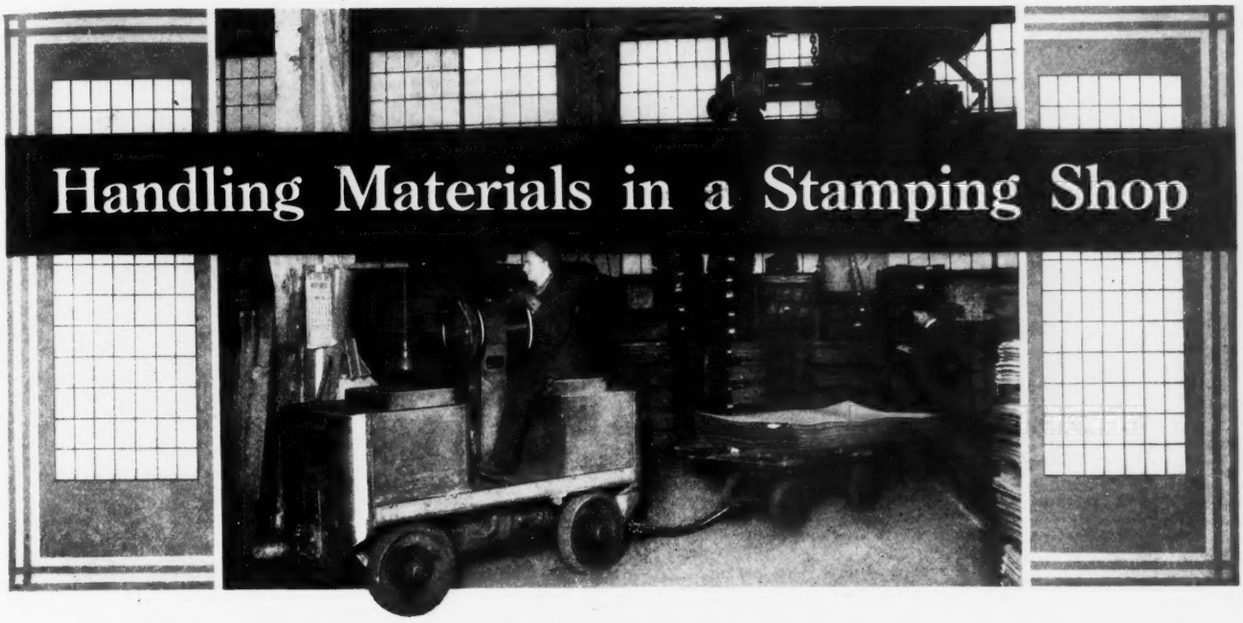
Handling Materials in a Stamping Shop



Systematic Methods Used in a Large Shop to Handle the Raw Material, Finished Product, and Scrap

By P. J. EDMONDS, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

THE problem of handling materials becomes one of increasing importance when the volume of work is large and requires uninterrupted flow through the entire shop. In the metal stamping department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., the monthly requirements for raw material amount to between 5,600,000 and 7,000,000 pounds, and the output of finished stampings per month varies between 4,000,000 and 5,000,000 pounds. Hence, the amount of scrap material that must be disposed of monthly fluctuates between 1,600,000 and 2,000,000 pounds. In this article, will be described some of the most important methods employed in handling this enormous amount of material from the time it is received from the mills to the completion of the finished stampings and the disposal of the scrap.

Unloading and Storing Raw Material

The raw material is received from the steel mills in sheet form. The box cars in which the material arrives are shifted two at a time into the storage warehouse on one of two tracks, which are depressed so that the floor of the box cars is on a level with the floor of the warehouse. Thus, a truck can be run into the cars without going up an incline.

A truck equipped with rubber wheels and roller bearings is used in unloading the cars. The truck is pulled into the box car by hand, with a wooden skid on it. Two men, one at each end of a pile of the sheet steel, lift approximately 150 pounds of sheets at a time to pile them on the skid. When about 5000 pounds of sheets have been piled up, the two men pull the truck out of the car by hand. A traveling crane is then used to lift the loaded skid by means of a double-loop sling chain, as shown in Fig. 1, and remove it to the proper place in the warehouse. Each kind of material is stacked separately to a height of from 10 to 12 feet. The warehouse covers a floor space of about 19,200 square feet. Fig. 10 shows the method of stacking and the simple design of the wooden skids.

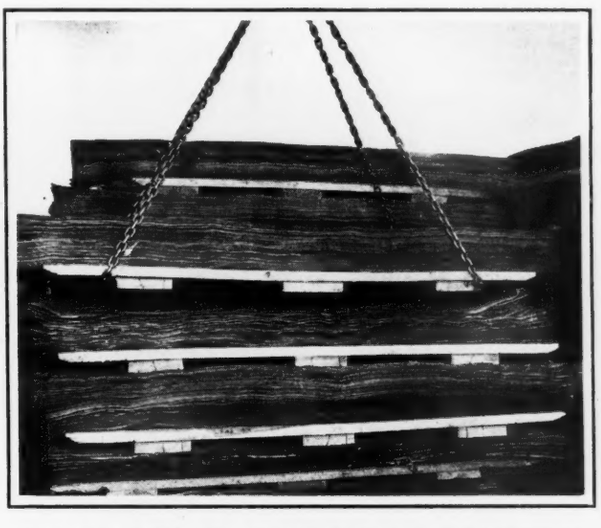


Fig. 1. Loaded Skid of Raw Material, Ready to be carried through the Warehouse and Shop by an Overhead Crane

Four men divided into two groups, and a material checker, work together in unloading a car. These men can unload a car in from 2 1/2 to 4 1/2 hours, the time depending, of course, upon the length and width of the steel sheets. The sheets vary in thickness from 0.014 to 0.125 inch, in width from 21 to 39 inches, and in length from 78 to 116 inches. From 70 to 90 carloads of sheet steel averaging 80,000 pounds in weight, can be unloaded monthly by the four men, and they are paid as a group on the tonnage basis. Approximately 15,000,000 pounds of sheet steel are carried in the warehouse at all times, to cover requirements, which represents enough stock to last from about nine to eleven weeks.

The skids used in transporting and stacking the stock are made out of two pieces of lumber, 2 inches thick by 10 or 12 inches wide, and 120 inches long. These pieces are held together by three cross members, 2 inches thick, which are suitably spaced. The skids are of various widths, depending on the width of the sheets.

Preparing the Sheets for Shop Use

When material is required in the shop, it is lifted from the stack by a crane, and placed upon a truck, similar to the one on which the material is removed from the box car. In this case, however, the distance from the warehouse to the shop makes

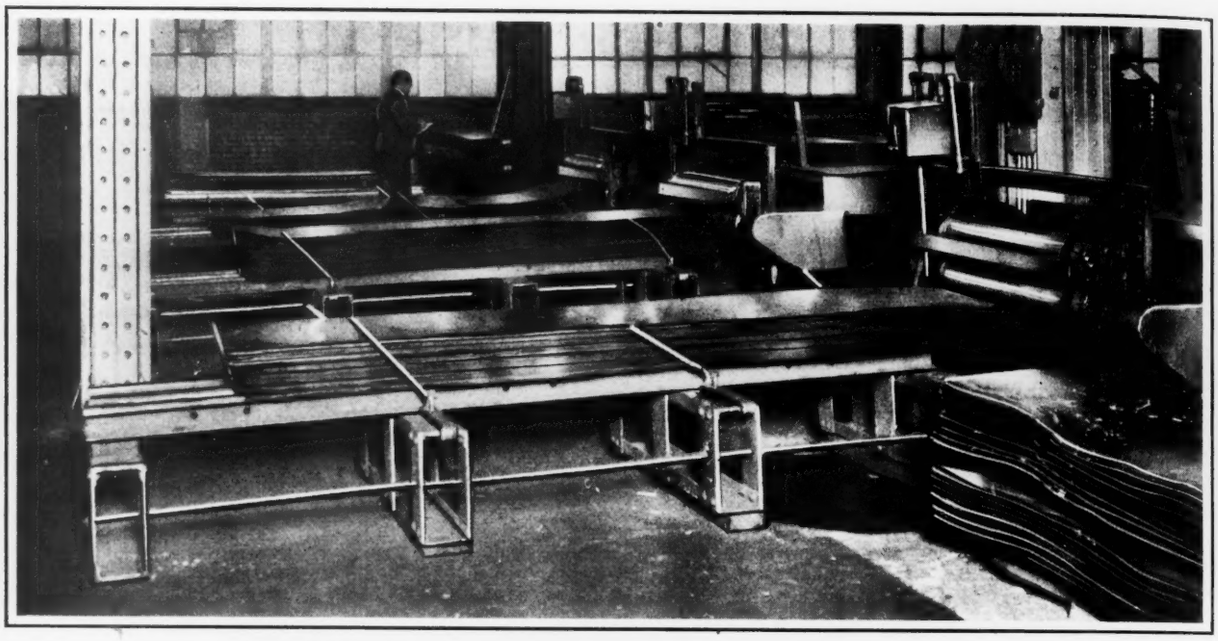


Fig. 2. General View of Machines employed in enameling Both Sides of the Steel Sheets

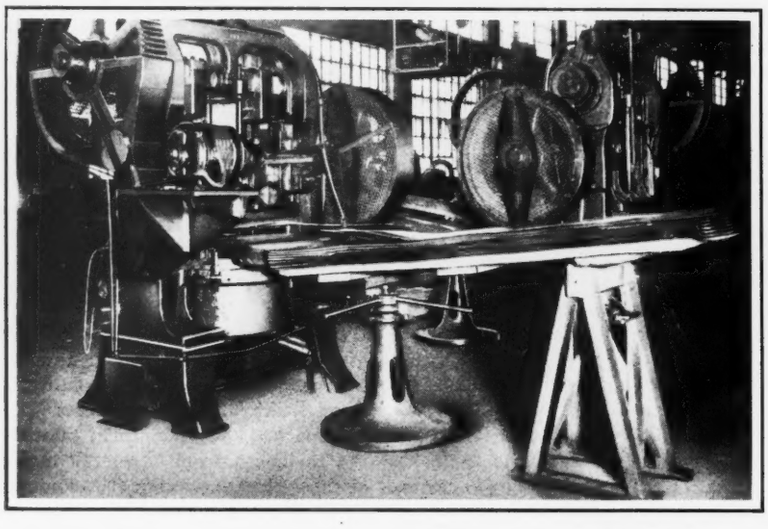


Fig. 3. Adjustable Stand at the Rear of a Power Press on which the Material to be blanked is placed

it economical to pull the loaded truck by means of an electric tractor, as shown in the heading illustration. After the material reaches the shop, it is lifted from the truck by a traveling crane, and placed on a table in front of one of three enameling machines.

The sheets are fed through the enameling machine, one by one, by means of a conveyor. As they reach the rear end of the machine, they pass between a pair of rolls, the speed of which is greater than that of the conveyor, so that they are shot out upon a cooling table, where they are evenly stacked, as illustrated in Fig. 2, by means of guide pins. A load of enameled sheets is lifted from the cooling table by means of a special lifting device that is used in connection with the traveling crane, and placed on a wooden skid. The loaded material on the skid is then lifted by the traveling crane, use being again made of a double-sling chain, and stacked on the floor to finish cooling.

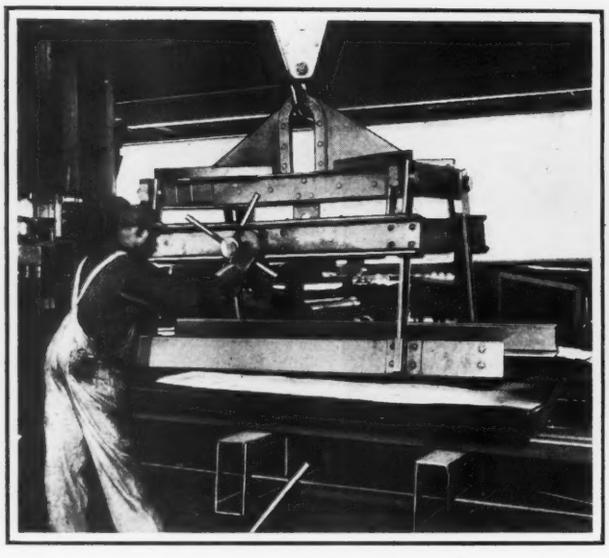


Fig. 4. Special Device used for lifting the Enameled Sheets from the Cooling Table and placing them on Skids

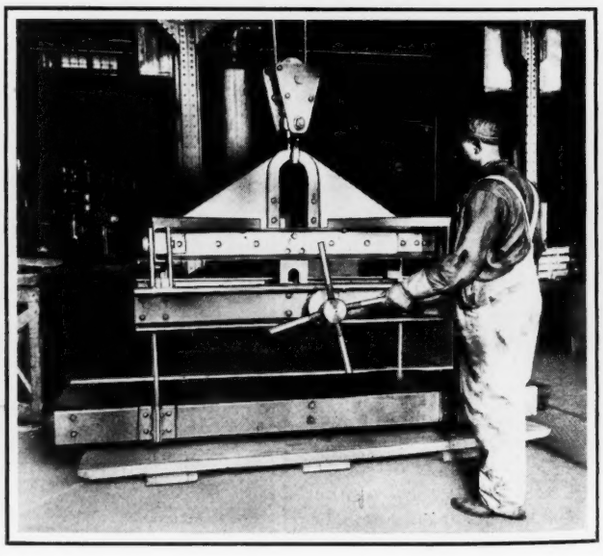


Fig. 5. Another View of the Special Lifting Device, showing the Sheets about to be deposited on a Wooden Skid

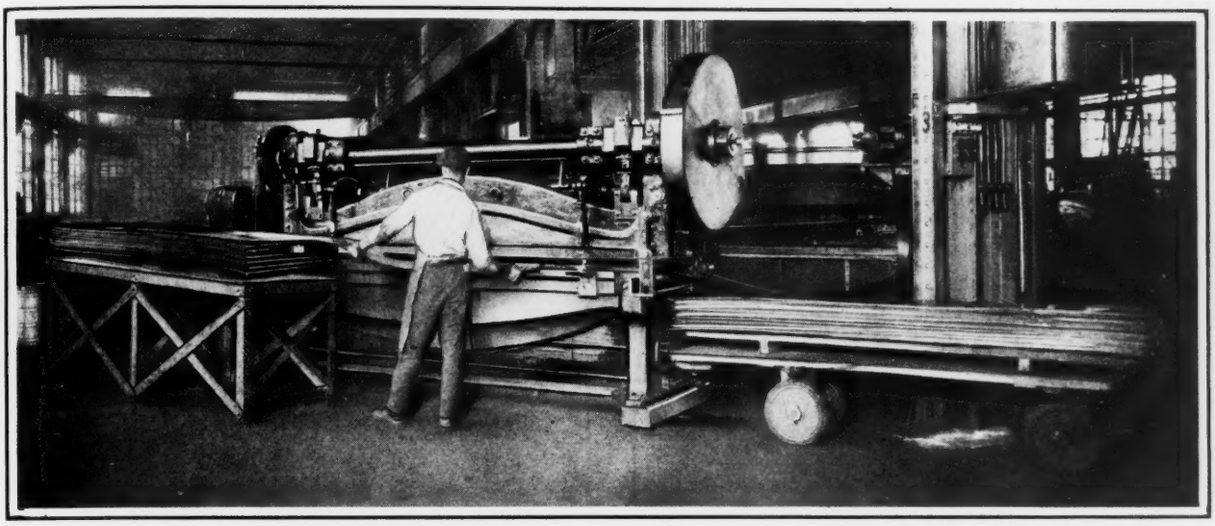


Fig. 6. General View of Operation in which the Sheets of Raw Material are sheared in Multiples of the Width

The special lifting device used in removing the sheets from the enameling machines is shown in Figs. 4 and 5. It will be seen that there are two long angle-iron jaws which are hinged to the top framework of the device. The jaws are opened and closed beneath a pile of sheets by rotating a capstan wheel, which actuates a central screw. This screw turns in right- and left-hand swivel nuts fastened to the hinged members of the device.

After the material has cooled, it is taken from the stack by a traveling crane and delivered on skids to the shearing machine shown in Fig. 6. Here the sheets are split into suitable widths. When shearing is unnecessary, the material is delivered direct from the stack to the presses. Special widths of sheets, which require no shearing, are carried in stock when the amount of production on any particular size justifies it.

The material to be sheared is placed by the crane on the table of the shearing machine, to the left of the operator. The latter picks up about 40 pounds of sheets at a time and pushes them through the shears to the back gage. After each cut, the back part of the sheets is stacked evenly on a small skid at the rear of the machine, as shown in Fig. 7, by fingers which support the strips until they are in a position to be sheared off, and which open at the down stroke of the ram.

At the front of the machine, to the right of the operator, as may be seen in Fig. 6, are two auxiliary rolls which carry off the front strips, and guide them evenly on a skid, while the operator reaches for more sheets to be sheared. The skid at the rear of the machine rests on a conveyor, and when it is filled to capacity, it is pulled by hand on the shuttle car seen in Fig. 7, and shifted aside.

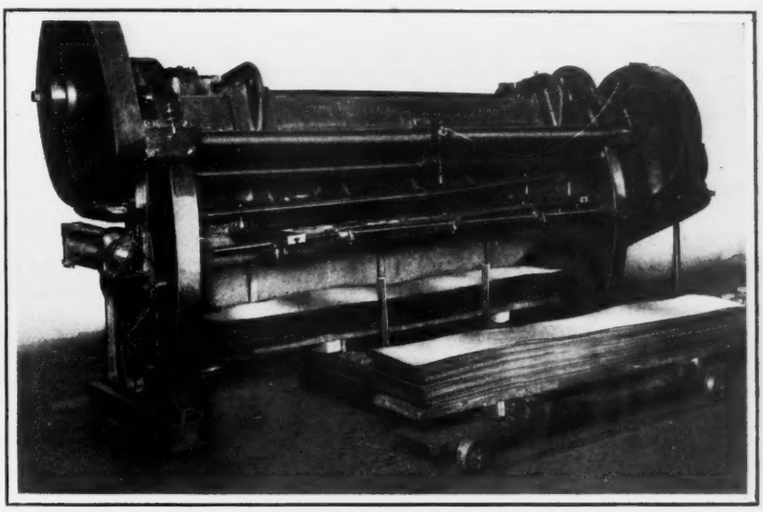


Fig. 7. Rear View of Shearing Machine shown in Fig. 6, illustrating the Method of stacking the Rear Part of the Sheets

Fig. 8. Dumping the Scrap from a Box onto the Floor, from which it is dragged into the Baling Machine

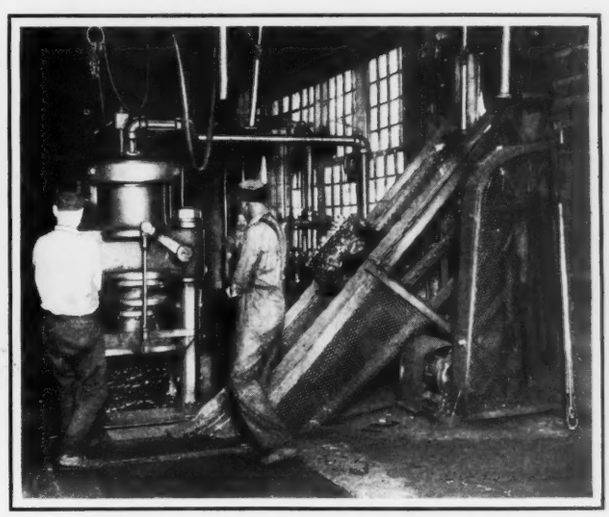


Fig. 9. Baling Machine, and Conveyor that carries the Scrap Bales directly into a Gondola Car

Fig. 10. Method of stacking the Skids of Raw Material in the Storage Warehouse after Removal from the Box Car

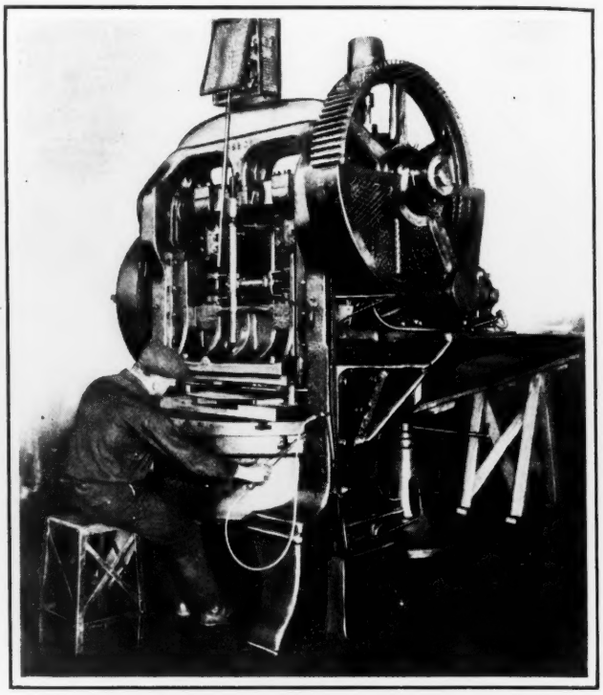


Fig. 11. View showing Operator using a Vacuum Device to pull a Sheet forward between the Dies

The skids used in connection with strips under 18 inches wide are usually made of a single piece of lumber, 2 inches thick by 120 inches long, and in widths depending on the width of the strips. Two strips 2 inches thick are fastened to the bottom of the skids, to provide space for a sling chain. One man, with the facilities just described, can shear from fifty to sixty thousand pounds of material in 8 3/4 hours.

Handling Problems in the Press Department

The material is now ready for blanking, and is delivered on the skid to the punch press by means of a traveling crane, and placed on an adjustable stand at the rear of the press. As shown in Fig. 3, this adjustable stand provides means for raising or lowering the load of material to facilitate the blanking operation. A vacuum lifter or suction device is used by the operator at the front of the machine to pick up a sheet from the load on the adjustable stand and pull it forward between the dies. It is not necessary, therefore, to have a man at the rear of the machine to pick up the sheets and push them into place for the operator to perform the blanking. Fig. 11 shows the operator holding the handles of the vacuum lifter. He controls the suction through a valve located in the right-hand handle. This type of suction device is used on 125 machines in the stamping department. All the devices are connected by pipe lines to one central vacuum pump.

During the process of blanking, the operator places the stampings at intervals on a tote plate. By the aid of stacking devices on the tote plate, the stampings are made ready either for the assembly section or for convenient handling in subsequent press operations. The tote plate is usually made of a piece of boiler plate, 5/8 inch thick and about 39 inches square. A 2 1/2-inch hole is punched in each of the corners of the plate, and the corners are bent up to an angle of 90 degrees, as may be seen in Fig. 12, which shows three industrial cars carrying loaded tote plates. The corner holes of the plates are engaged by the hooks of a sling chain when the load of material is to be lifted. The stacking devices are usually of a box shape or skeleton type, designed primarily to keep the stampings stacked evenly on the plate—in many cases, with respect to an assembly mark.

When the finished material is ready for shipment to the assembly section, it is transported on the tote plates, and these are securely clamped on the industrial cars by means of a special device clearly seen on the trucks in Fig. 12. The distance from the metal stampings department to the assembly section is approximately one mile, and the road over which the cars must travel, makes it necessary to fasten the load of stampings securely to the car. The clamping device consists of two or four 7/8-inch rods, about 36 inches long. One end of the rods is threaded, and the other bent to a hook shape. One or two pieces of 4-inch channel iron, 42 inches long and having a slot in each end, are placed on top of the load. The rods are hooked underneath the sides of the car and passed up through the slots in the channel iron. Four-inch square washers are placed over the rods on top of the channel irons, and by means of steel handles tapped to suit the rods, the load of material is screwed down securely to the tote plate.

Fig. 12. Finished Stampings on Tote Plates loaded on Industrial Cars for Delivery to the Assembly Section

When the destination is reached, the clamping devices are removed, and the tote plates, with the

stampings in place, are delivered by a traveling crane, either direct to the assemblers or to a place where they are stocked until needed. There is no intermediate handling of the stampings from the time the operator places them on the tote plate at the punch press in the metal stamping department until they are delivered to the assembling department.

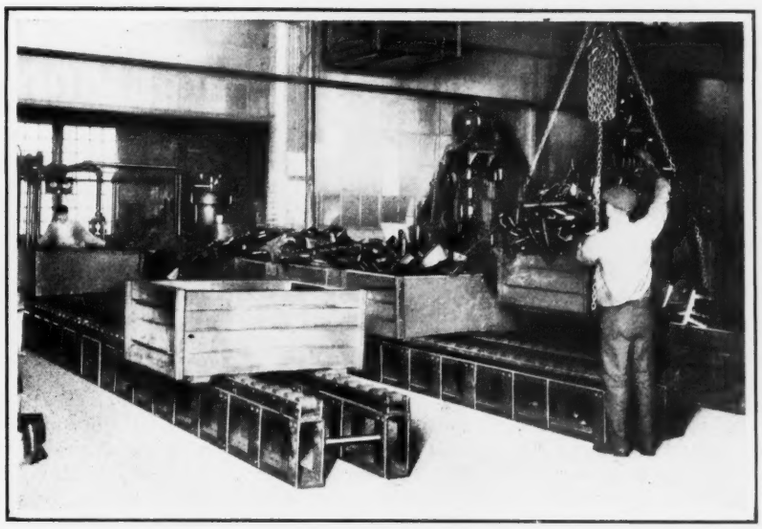


Fig. 13. Conveyors employed in moving the Loaded Scrap Boxes into the Baling Room and returning the Empty Ones

Disposal of the Scrap

Keeping the floor free from scrap is of no less importance than keeping production flowing through the shop, since the scrap amounts to between 1,600,000 and 2,000,000 pounds monthly. During the blanking operations, the operator folds the scrap, and after the last blank has been stamped out of a sheet, throws the scrap into a large box. These scrap boxes are so arranged on the floor that the operators have no difficulty in throwing the scrap material directly into them. This makes it necessary to have a sufficient number of boxes for each operator. The boxes are made of 2-inch hard wood, and are 48 inches long by 36 inches wide by 24 inches deep. A number of these boxes have been in service from five to six years, and aside from a few minor repairs should last at least ten years longer. The perforated disks of scrap that fall through the dies are gathered up by laborers and thrown into a box.

After the scrap boxes have been filled, they are removed from the floor by a traveling crane and placed on the conveyor shown at the right in Fig. 13, which carries them to the baling room. The conveyor at the left is used for returning empty boxes from the baling room to the shop.

As the boxes enter the baling room, one by one, they are dumped, as illustrated in Fig. 8, and the scrap material is dragged into the pit of a baling machine by an operator and two helpers, using hooks with long handles. After the scrap has been baled, the empty box is transferred on a shuttle car to the conveyor leading back into the shop, from which it is removed by a traveling crane and placed in service again. The bale of scrap is pulled from the lower plunger of the baling machine onto the inclined conveyor by the two helpers, in the manner shown in Fig. 9. The conveyor carries the bale directly to a gondola car outside of the building to be shipped back to the steel mill. The three men at the baling machine also perform their work on a tonnage basis. In 8 3/4 hours, they bale, on an average, 85,000 pounds of scrap, dumping the scrap boxes, shifting the boxes to the outgoing conveyor, filling the pit of the baling machine with scrap, baling, and pulling the bales from the lower ram onto the inclined conveyor.

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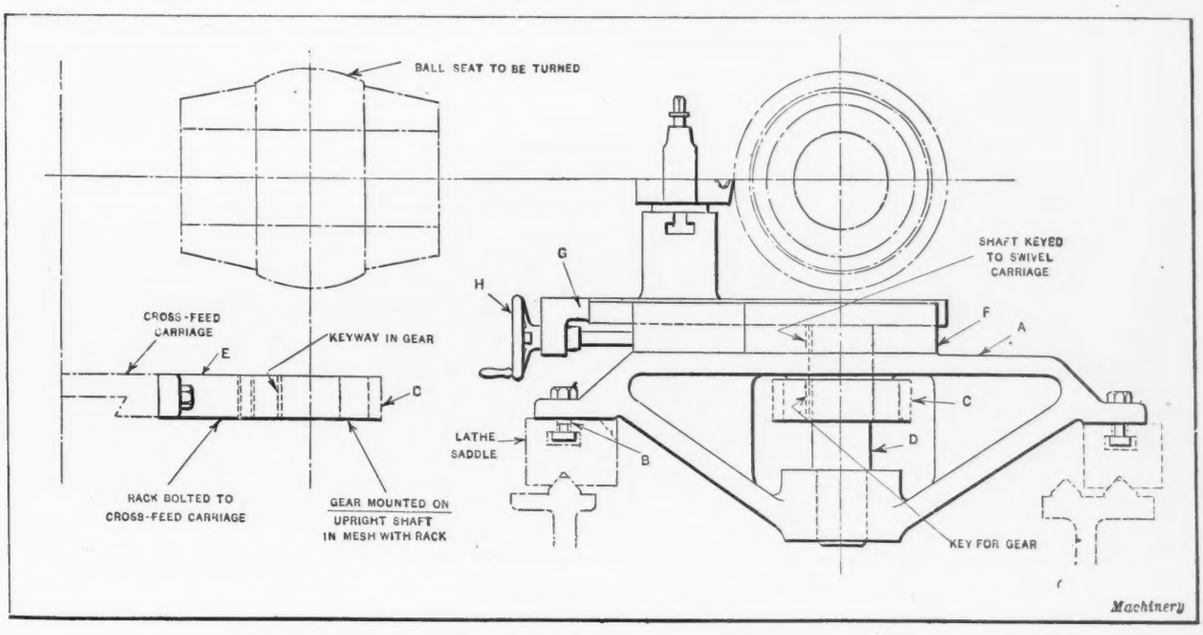
TURNING BALL SEATS ON STEAM TURBINE BEARINGS

By C. W. PUTNAM

The lathe attachment shown in the accompanying illustration is employed for turning the ball or spherical seat on the shaft bearing of a Curtis steam turbine. This attachment proved to be less expensive to construct than the customary worm and worm-wheel type of spherical turning attachment. The cast-iron frame *A* is machined to fit the saddle of the lathe, and is provided with a tongue at *B* to maintain proper alignment. The gear *C* which is mounted on the shaft *D* meshes with the rack *E* secured to the carriage cross-feed slide.

By feeding the carriage cross-slide in or out, the swivel carriage *F* is made to pivot about the center of shaft *D*. The toolpost is part of the slide *G*, which is mounted on the swivel carriage *F*. The handwheel *H* provides for adjusting the tool to turn spherical surfaces of different diameters.



Lathe Attachment for turning Spherical Surface on the Shaft Bearing of a Steam Turbine

Training Apprentices on the Pacific Coast*

By PAUL ELIEL†, Director of Industrial Relations Department, Industrial Association of San Francisco, Cal.

THE entire Pacific Coast presents a unique industrial situation. Manufacturing of all types has been comparatively slow to develop here, due to a variety of causes. The absence of coal has militated against the development of any basic iron and steel industry, although this difficulty has to some extent recently been met through the extensive developments of coal and iron deposits in Utah, from which pig iron is shipped to Pacific Coast plants for conversion and rolling. The predominantly agricultural character of the entire West has also tended to give to the area an economic tone chiefly associated with an agricultural background. Hence, even today, with some eight million people tributary to the Pacific Coast slope, manufacturing is only in its infancy, and but few plants of any size are located in the three Pacific Coast states. These conditions naturally have not been favorable to the development of apprentice-training courses.

Other features that have to some extent militated against the development of a progressive and forward-looking training program have been the part-time education laws, which in California require all children to attend school up to the age of sixteen, and also require five hours of school attendance per week between the ages of sixteen and eighteen. Under these conditions, such enterprises as are already established on the Coast are, in general, just beginning to think about the problems of trade training.

Extent of Trade Training and Different Methods Used

A large number of inquiries disclosed the fact that, with one notable exception, there is not a single industrial establishment on the Coast at present with more than a haphazard and rudimentary apprentice-training program. Other agencies, however, have been giving consideration to this problem with varying degrees of success. All the larger communities in the state of California, with the exception of San Francisco, have taken advantage of the provisions of the Smith-Hughes Act, and have developed extensive courses of vocational education. In addition, there are privately endowed trade schools in the Coast area which have devoted considerable attention to the training problem. Finally, there is at least one notable contribution to the problem of training for industry that has been undertaken by a purely private organization, namely, the work done by the Industrial Association of San Francisco.

Vocational Schools and Their Work

Of the purely vocational schools, the work done at the Benson School in Portland is undoubtedly the best of any of the public or private efforts on the Coast. This school has a series of excellently equipped shops in which a considerable amount of commercially useful work is carried on. This school has recognized the necessity for more definite contact with shop problems than is customarily found in vocational schools, and requires its students to complete at least 2400 hours of shop work before graduation. In its vocational courses, which comprise blacksmithing, patternmaking, machine shop practice, foundry work, toolmaking, cabinet making, carpentry, plumbing, sheet-metal work, electric work, gas engine practice, and the printing trades, one-quarter of the student's time is devoted to drawing and applied sciences, one-quarter to mathematics, English, and civics, and one-half to work in the shop.

Even here, however, with the most intensive effort on the part of the school authorities to create a practical atmosphere, the graduate of the school, after three or four years of instruction, depending upon the nature of the course taken, is certainly not so well equipped as the apprentice in a plant that is carrying on a carefully thought out apprentice training program.

The Lick Wilmerding School in San Francisco has recently made a careful survey of trade-training programs, and is about to inaugurate a plan for cooperative relations with industrial concerns, looking toward the establishment of the "work-study" plan, under which shop experience will be gained in commercial shops, while the school will largely devote its attention to related subjects.

The author of this article points out that with one notable exception there is not a single industrial establishment on the Pacific Coast at present that has a systematic and thorough apprentice training program. Vocational training, however, has not been overlooked by the educational authorities, and all the larger communities in California have developed extensive courses of vocational education. In addition, there are numerous endowed trade schools, and finally, the problem of training for industry has been successfully attacked by the Industrial Association of San Francisco.

Apprentice Training at the Caterpillar Tractor Co.'s Plant

Turning now to the one example on the Coast of a complete trade-training program within an industry, the work done at the plant of the Caterpillar Tractor Co. is of an outstanding character. Apprentices are required to sign an actual form of indenture which, among other things, provides that they must successfully complete approximately 9000 working hours in the shop, and must have obtained practical experience of a satisfactory character in the several operating divisions of the plant. The problem in this plant is made simpler owing to the fact that while they are working on a very high production schedule for the West, no progressive or string operations are undertaken outside of the actual assembly floors, although the materials are carefully routed through the plant from process to process.

The most interesting aspect of the work done in this shop relates to the effort made by the supervisor of training to develop a flexible system which will provide for the individual skill, aptitude, and requirements of the various apprentices. For example, there is no definite schedule of progression of the apprentice from tool to tool in the shop, but merely the general requirement that he shall put in approximately two and one-half years in the production departments and one and one-half years in the so-called auxiliary department. This latter department comprises a number of subdivisions, the most important of which is the tool-room, where the apprentice is required to spend a considerable time on lathes, millers, and bench work. Also included in the auxiliary departmental work is the heat-treating department, the general inspection department of the plant, and the service shop.

Divisions in the production department are the tool crib, drilling department, hand milling, rough grinding, screw

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machine, turret lathe, engine lathe, tool-room, grinding, and assembling department. In connection with all of this work, it must be borne in mind again that there is no effort to route men through it in accordance with any predetermined plan, but the apprentice supervisor makes an effort to watch the individual requirements of each of the apprentices and to so place him that he will progress as rapidly as possible through the several phases of the work, with such assigning from tool group to tool group as may appear to be the most desirable to suit the individual need.

Class-room Work in Related Subjects

In addition, there is an extensive course offered in shop mathematics, to which the apprentice is required to devote at least five hours per week of his time. Here, again, an effort is made to provide the utmost flexibility, depending upon the actual knowledge of the apprentice prior to his entrance into the shop and on his natural aptitude. No apprentice is accepted who is not able to perform the fundamental arithmetical operations relating to fractions and decimals. Beyond this point, the plant school offers a complete schedule of fundamentals, which include such pure mathematical processes as involution and evolution; geometry and mensuration; and elementary trigonometry; as well as elementary mathematics of pulleys and gearing; the nomenclature, types, and uses of threads, gears, and lead-screws, graduated dials, cutting speeds and fits, tapers, spur, bevel, and worm gears; the use of the sine bar; and elementary shop physics and mechanics.

In addition, the apprentice is required to devote a considerable amount of his time to mechanical drawing, depending upon his individual skill and aptitude. No effort is made to develop mechanical draftsmen, the aim being merely to teach the student to make a representative and understandable shop drawing and to interpret any blueprint that may come to the mechanic's attention. Among the elements covered in this phase of the work are geometrical construction, projection, auxiliary and revolved views, sections, shop sketching, working drawings, and tool design.

In addition, there are a number of shop talks given during the course of the apprentice's training covering general problems in the shop and such important related subjects as cutting tools and their elements, cutting compounds and lubricants, fundamentals of the several main classes of machine tools, gaging principles and methods, shop systems and organization problems, and general topics relating to safety, shop habits and operation, etc.

The Caterpillar Tractor Co.'s plant is operating on a modified Taylor-system basis, and all jobs in the shop are controlled by standard times, determined through time study. During the apprentice's tour through the various tool groups, he is required to work upon the same materials and parts as come to the mechanic in the same tool division, and the apprentice's time on these parts is scheduled against standard time for the same operation.

Incentive Method of Payment is Employed

Monthly records are kept for each apprentice, and a monthly average on all the operations on which he is engaged is compared to standard time for the same operations. Each month the apprentice making the best record, as compared to standard times, is allowed an increase in his wages for the following month equivalent to the increased wage that he would normally receive during the next half-yearly term of his training. The apprentice begins work at approximately 30 per cent of the standard journeyman machinist's wage, and his wages increase approximately 5 per cent of such standard wage for each six months of his term of apprenticeship.

At the Caterpillar Tractor Co.'s plant, the apprentices complete about 9000 working hours in the shop, and obtain practical experience in a number of the departments of the plant. Approximately 2½ years are spent in the production departments, and 1½ years in the tool-room, heat-treating department, inspection department, and other auxiliary departments. A school is also provided in the plant, giving an extensive course in shop mathematics, mechanical drawing, and elementary mechanics and physics. The payment of the apprentices is based on the incentive method.

The company provides the apprentice at the beginning of his term with a set of tools valued slightly in excess of $16, for which the apprentice is required to pay, but the cost of these is refunded to him when he has satisfactorily completed his first two years of training, the tools then becoming his personal property. At the beginning of his third year of training he is provided with a set of more advanced tools for which he must also pay, but the cost of these also is refunded to him by the company at the termination of his apprentice course, at which time they become his property. A regular diploma certifying that the apprentice has completed the course is offered at the end of the four-year program, and a certificate is offered at the end of three years of training, at which time the apprentice is permitted to withdraw from his indenture if he so desires.

The supervisor of training has not employed any special technique for examining applicants, but relies almost entirely upon personal interview. He will not, however, as already mentioned, accept as apprentices boys who do not possess a knowledge of the rudimentary mathematical operations involved in the use of fractions and decimals. The Caterpillar Tractor Co., which employs about 500 men at its San Leandro plant, attempts to maintain a group of about twenty-five apprentices at all times in its shops.

Trade Schools of The Industrial Association of San Francisco

Mention has already been made of the work which is being done by the Industrial Association of San Francisco in connection with training for industry. While most of the effort of this organization has been devoted to the application of training methods to the building trades, it now has in operation a very successful foundry school, which is generally considered to be one of the most outstanding developments in foundry practice in the country.

Since the association has no actual plant at its disposal, it has approached the problem of trade training from a special angle. An analysis of the attitude of employers to the hiring of apprentices has indicated that, in general, they are not disposed to look favorably upon apprentices because of the difficulties and the liabilities involved by the employment of these absolutely unskilled men. The association therefore decided to attempt to meet this difficulty through the provision of groups of short-time intensive-training courses. The object of these courses is to provide merely a sufficient grasp of the rudimentary operations of the trade in order to acquaint the apprentice with enough of the actual craft skill so that upon the termination of this course, he may be employed and actually earn his way from the start. In approximately three years and a half, the association has had more than 1200 men in its several schools. The proof as to the applicability of this method lies in the work that these apprentices have done on various building projects in San Francisco during this time. A number of these men have been promoted to positions of foremen and superintendents, and others are actually engaged as journeymen upon the more difficult and intricate phases of their craft. All the present work is being carried on at night schools, with employers' committees actively engaged in attempting to develop the fundamentals of each craft's training.

The entire technique and work of the Industrial Association affords an interesting example of the type of work that can be done in connection with a group of employers, none of whom could undertake an apprentice-training program individually, but who, through a community of effort and a common interest in the apprentice problem, are able to develop constructive and valuable training programs that are of benefit to the industry as a whole.

Arc Welding in the General Electric Plant

By M. A. ATUESTA

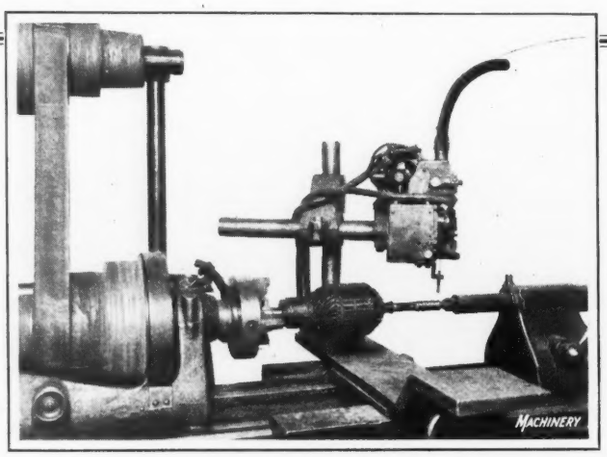


Fig. 1. Building up a Worn Armature Shaft by Electric Arc Welding

ARC welding has been used in regular manufacturing work at the different works of the General Electric Co. for several years with marked success. Its introduction has been responsible for a change in design of some of the lines of apparatus, whereby arc-welded boiler plate has been substituted for cast iron. In a great many cases, electric welding has taken the place of gas welding, effecting considerable savings. It is of interest to note that, as early as 1913, twelve arc welders were used on thin sheet-steel (1/16 and 3/32 inch) transformer tanks in one of the factories. The seams were welded by means of the carbon arc, there being no metallic electrode holders employed at that time. Today the same factory employs fifty-seven arc welders, fifty-two using the metallic electrode, and five using the carbon electrode. Each month they consume more than one thousand carbon pencils, 13,500 pounds of welding wire, 40,000 kilowatt-hours of electrical energy, and do 67,500 feet of welding.

Different Lines of Apparatus on which Arc Welding is Used

Tanks for transformers, regulators, metering equipments, conservators, transformer breather pipes, treating and dipping tanks, trucks, racks, and bushing adapters are now being arc-welded. From several years of experience in making oil-tight joints and seams such as are required on transformer work, it has been found that arc welding is about 15 per cent cheaper than riveting, and about 20 per cent cheaper than gas welding. These figures are estimates based upon average conditions. In some tanks, a saving of 13 cents per foot on electric welding, as compared with gas welding, has been recorded. In one plant, where welding has replaced castings on the tops and bottoms of some of the transformers, a 25 per cent saving was made.

In the welding of thin sheets up to 1/16 inch, the cost of gas welding is not any higher than arc welding, while for thicknesses greater than 1/16 inch arc welding is much cheaper. Satisfactory oil-tight seams cannot be made in steel much thinner than 1/8 inch by riveting. Riveted seams in this thin steel are usually soldered, or a gasket is employed to guarantee a tight joint. With the electric arc, this is not necessary.

Electric locomotive parts, mine locomotive parts, battery boxes, cabs, gear-cases, air compressor frames, air compressor crankshafts, and controller frames are also welded by the electric arc. In this particular line of work, arc welding has taken the place of riveting for motor gear-cases, battery boxes, miscellaneous brackets, and cabs. Studs in split gears are secured by the carbon arc. By the use of heavy currents, deep penetration is secured. Gas welding cannot be used for this work, due to the gears being heat-treated. The average saving on this line of work is approximately 25 per cent.

Arc Welding on Motor Parts

Motor frames made of 5/8-inch thick steel plate, rolled and welded by an automatic machine, have displaced the steel casting, with a saving of $2 per frame. Laminated pole pieces are welded after assembly to prevent their creeping

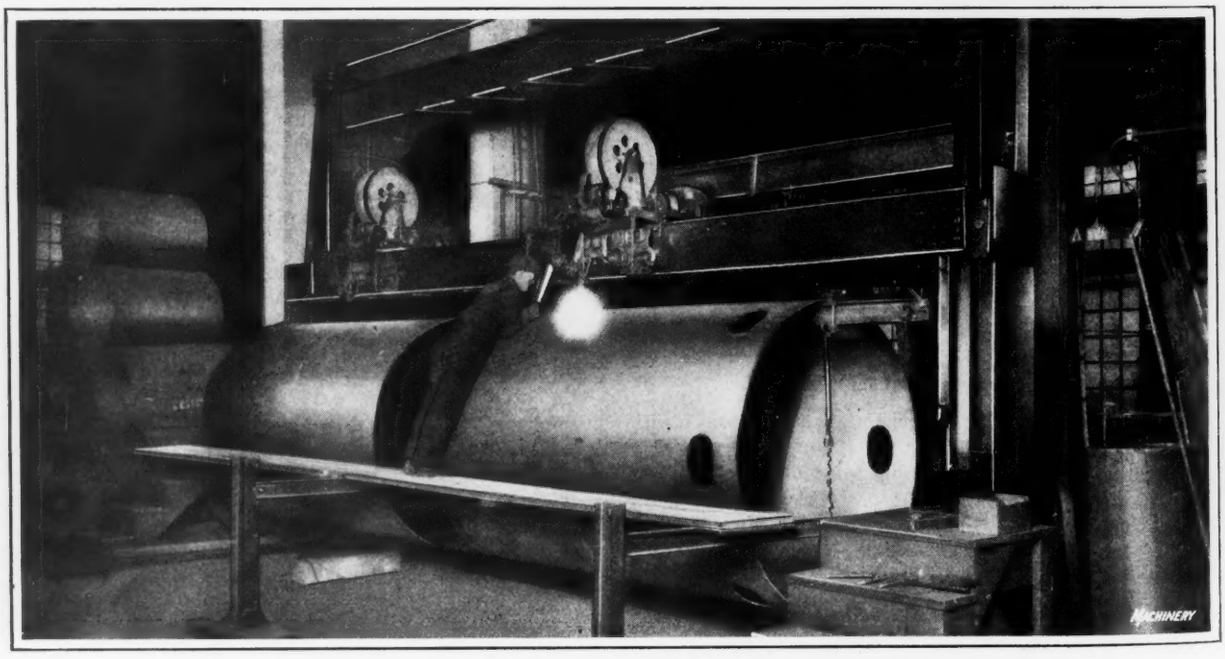


Fig. 2. Welding the Longitudinal Seams of Large Tanks by an Automatic Tank Welding Machine

when being drilled and tapped. Commutator shells made of stamping steel are assembled by arc welding. Their weight is much less than the cast shell, and no machining is required. Bases for motors and motor-generator sets are made of channel iron and I-beams, arc-welded together. The outstanding feature of these bases is light weight, combined with strength and quick assembly. They have in many cases replaced the cast-iron base. The saving effected on this kind of work has been 25 per cent.

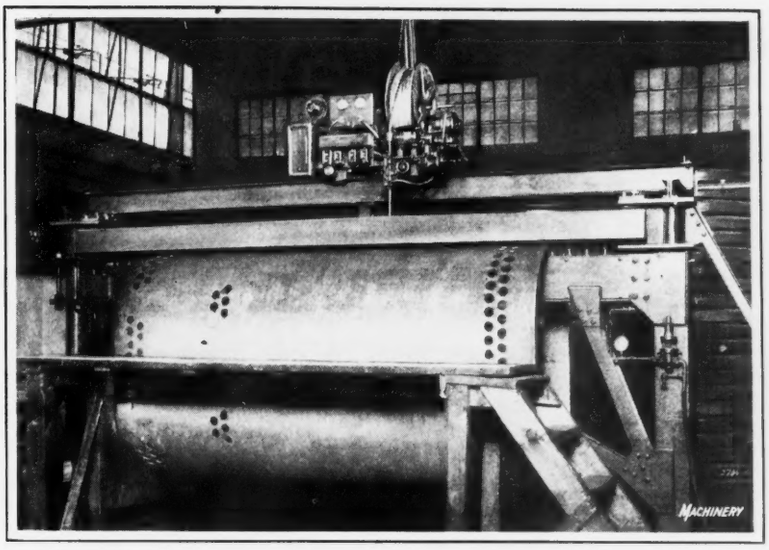


Fig. 3. Machine for automatically welding Tank Shells made from ¼-inch Boiler Plate

Induction motor field punchings are pressed into a seamless steel tubing, and the end rings arc-welded, which does away with rivets through the punchings. While no particular economy in manufacture has been effected, this method results in a better field, because the increased compactness avoids loose laminations. Terminal boards for motors which are arranged for armored conduit connections are assembled together by arc welding, due to the high speed of operation.

Welding Generator Stator Frames

Generator stator frames which were formerly made from castings are now fabricated from steel plate and arc-welded. The saving from this change is considerable. Clamping fingers for holding punchings in stator frames, originally made of castings, are now being made of bar iron, arc-welded together. It is rather difficult to estimate the saving resulting from this particular line, but it is at least 25 per cent. Oil-pans for vertical water-wheel-driven alternators, previously made by riveting and soldering to obtain leak-proof joints, are now arc-welded. While the saving, so far as manufacturing is concerned, is not large, complaints from leaky joints have ceased.

Oil switch tanks, originally made by gas welding, were produced by arc welding several years ago, with a saving of 20 per cent. After the automatic welding method was introduced on these tanks, an additional 15 per cent was effected, making a total saving of 35 per cent. Since introducing arc welding on this line, steel framework, sheet-steel solenoid housings, galvanized framework, and rotary auxiliary switches are being welded.

Tanks of various kinds used in the factory—water, water rheostat, and slip regulator tanks—which in most cases were riveted, are now being welded at a saving of approximately 25 per cent.

Reclaiming Cast-iron and Steel Castings

Large steel castings for turbine and other work are now being saved and made usable by the use of arc welding. It is not possible to estimate the savings effected in this line of work, owing to the fact that prior to the use of arc welding many of these castings were rejected and had to be replaced by new castings, there being times when the defects were not discovered until machining operations had been started. All this trouble has been eliminated by arc welding.

Welding Miscellaneous Shop Equipment

Steel racks, lockers, cabinets, and shelves for the rubber department are now being welded, showing a saving of as much as 40 per cent. Jig and fixture frames are cut and assembled by arc welding. This does away with an expensive pattern which is used only once. Many times the completed jig costs less than the pattern itself. One important saving in this line of work is time. Supporting pipes for switch-

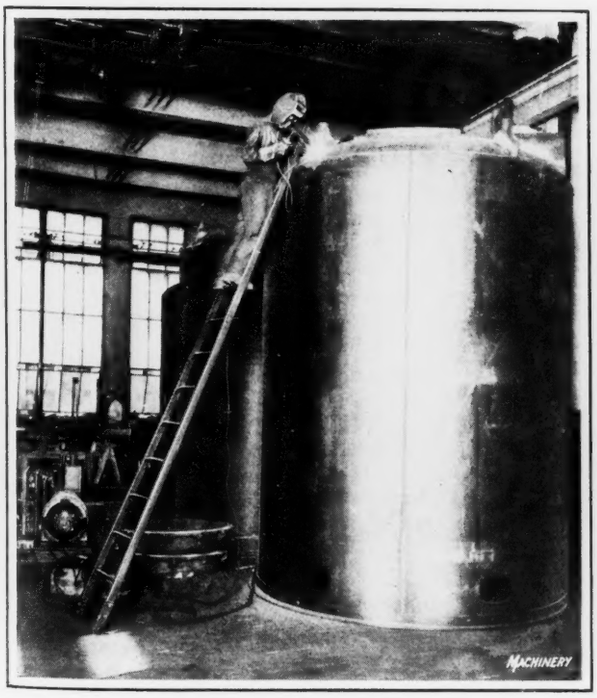


Fig. 4. Welding Oil Circuit Breaker Tanks 13½ Feet High and 9½ Feet in Diameter

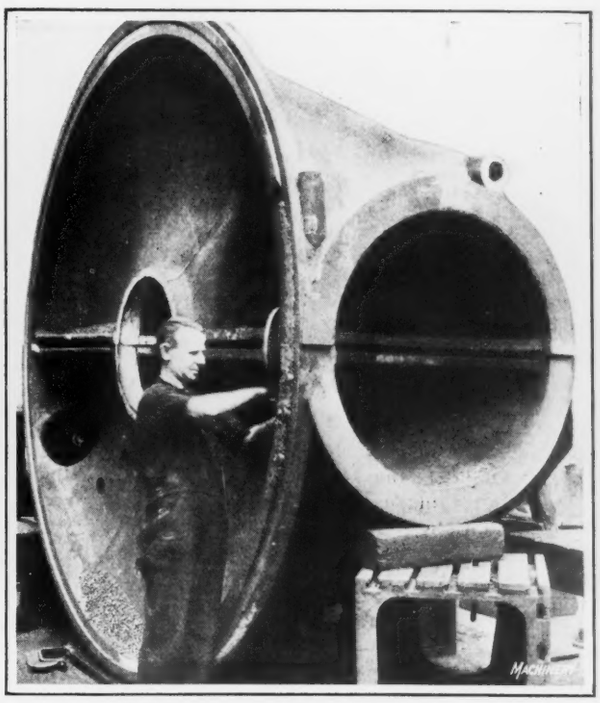


Fig. 5. Salvaging Large Castings in which Blow-holes have been filled by using the Electric Arc Welding Method

board panels, and foot plates of pipes for fastening to the floor were originally tapped and threaded. These are now being arc-welded instead, at a saving of between 2 to 3 cents each, more than 100,000 being used in a year.

Flanges for holding pipes together were originally threaded to the pipe, and in some instances welded with gas. By making a slight change in the piping and flange, an oil-tight joint can now be made by arc welding. Compressor casings can be welded only by the arc process. The chief advantage of welding is the fact that it is relatively easy to make changes, and this is not practical with castings.

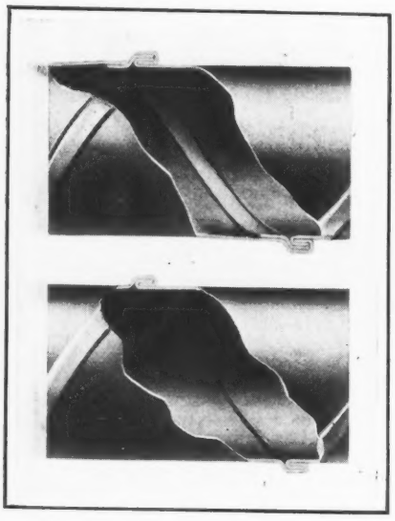
Building up Shafts by Arc Welding

A great many armature shafts used throughout the factory, that have become worn at the journal or at the coupling or pulley fit, are now being welded without stripping the armature, thereby causing a great saving, which is rather hard to estimate. In many cases, a complete armature is reclaimed by merely building up the shaft. This work has been done automatically.

* * *

SPIRAL-WOUND PIPE OF INTERESTING CONSTRUCTION

Sheet steel in strip form is wound spirally to produce rivetless pipe of the two designs shown in the accompanying illustration. In the same operation, the edges of the strip are automatically flanged and formed into a four-ply lock-seam, which is produced on the outside of the pipe in order that the internal diameter may be constant. The pipe is manufactured by the Naylor Spiral Pipe Co., 1230 E. 92nd St., Chicago, Ill., from No. 16 to No. 10 gage sheets in diameters ranging from 4 to 30 inches. The pipe is formed in a continuous piece, and then cut into lengths up to 40 feet. In forming the pipe, it is wound under a high tension around a turned arbor. The upper pipe in the illustration is made of high-carbon steel, and is used for conveying abrasive materials, while the lower pipe is for carrying water, air, gas, etc.



Two Examples of Spiral-wound Lock-seam Pipe

* * *

UNVEILING OF THE JOHN ERICSSON MEMORIAL

A notable event in the history of American engineering took place at Washington May 29, when the memorial erected by the United States Government to John Ericsson, the famous engineer and inventor, was unveiled. This is the first time in the history of the United States that a memorial has been erected by the United States Government to an engineer. The monument is located in Potomac Park, in close proximity to the Lincoln Memorial.

At the unveiling exercises, the principal addresses were made by President Coolidge and by the Crown Prince of Sweden, who has come to the United States for the purpose of being present at the dedication of the monument. Representatives of engineering societies from all over the United States and from Sweden were present. John Ericsson's life work during a period of fifty years was performed in the United States, although he was born and received his education and early training in Sweden. He was born in 1803 and came to the United States in 1839. He died in 1889.

NEW RAILROAD EQUIPMENT MORE EFFICIENT THAN OLD

The new locomotives installed on the railroads of the United States during the last four years, totalled 10,105, and in the same period, 10,962 were retired. Thus there was a net decrease of 857 during the four-year period. These facts are brought out in an analysis of the railroad equipment situation made by Dr. Julius H. Parmelee, director of the Bureau of Railway Economics. Dr. Parmelee says in part:

"This apparent decrease in motive power does not, however, tell the story, inasmuch as the new locomotives were of greater weight and far greater power than those retired. The final result, in terms of aggregate tractive power, was a net increase in average tractive power per locomotive from 36,935 pounds in 1922 to 40,625 pounds in 1925. In other words, although the number of units decreased, the amount of available tractive power increased.

"The extent to which the addition of larger and more powerful locomotives has offset the retirement of older, smaller, and less powerful types, is well illustrated by reference to the figures of installations and retirements in 1925. In that year a total of 3005 locomotives were retired, while only 1733 new units were installed. Yet the aggregate tractive power of the new units nearly equaled the aggregate power of the retirements, due to the much greater average power of the new locomotives. The 3005 locomotives retired had an average tractive power of 32,394 pounds each, or an aggregate of 97,344,562 pounds; the 1733 locomotives installed had an average power of 52,798 pounds, or an aggregate of 91,499,557 pounds.

"In the case of freight cars, a larger number were installed than retired during the four years ending with 1925. The net increase was approximately 43,000 cars. As was true of the motive power during the same period, this comparatively small net increase in freight car units by no means indicates the extent to which the railways replaced smaller types of worn out and obsolete freight cars by larger types of modern and up-to-date cars. The net result of the large program of car retirement and replacement carried out by the railways during the four years was an increase in the aggregate freight car capacity of 6,986,000 tons, and an increase in the average capacity per car from 42.5 tons to approximately 44.7 tons.

"Here again, as in the case of the locomotives, the new cars were of greater average capacity than those retired. In 1925, for example, the 117,021 freight cars retired had an average capacity of 38.77 tons, or an aggregate of 4,537,287 tons; the 125,760 cars installed had an average capacity of 47.37 tons, or an aggregate of 5,956,930 tons."

* * *

LINK-BELT METHOD OF TRAINING SALESMEN

During the course of a year any large organization finds it necessary to add new men to the sales force. The new men, regardless of their previous experience or training, must be coached in company policies and standards of practice. They must be educated as to machinery design and construction before success as a salesman can be expected from any one of them.

Realizing that this education and training is most expensive and that at best it can be accomplished only over quite a period of time, the Link-Belt Co., of Chicago, Indianapolis, and Philadelphia, has adopted the policy of holding annual sales schools. The most recent of these schools was held at the Link-Belt Indianapolis plant in May. Not only does this type of "school" permit the salesmen to inspect the plants in which many types of malleable iron and steel chain for elevating, conveying, and power transmission are manufactured, but it also serves many other important functions. It offers an opportunity for the interchange of ideas among the men themselves, coming as they do from widely separated points; and makes for better feeling, real fraternity, and a dissemination of valuable sales information.

Shop Records that Increase Efficiency

By J. SETON GRAY, Industrial Engineer, A. O. Smith Corporation, Milwaukee, Wis.

IT is essential, in conducting any business or any department of a business, to have accurate cost figures available at all times. These figures should be so recorded that they can be used readily by the management in checking the results obtained throughout the factory. It is very seldom that the records in a factory are really useful to the factory organization. The generally accepted idea is that the chief clerk or works accountant knows what is required, and the information he furnishes is generally used by the president and the board of directors; but actual facts that could be of use to the factory organization are not obtainable unless the general superintendent or the departmental foreman collects them himself.

In many factories, not a single report is ever submitted to the factory organization to let them know how the factory is running, and it becomes a habit for the men to say: "So long as we hear nothing from above, everything must be all right." Under these conditions, there is no inspiration to the factory organization to improve conditions.

The Purpose of Cost Records

Records of costs must be made to determine not only whether a profit is being made on the product, but also whether the cost of manufacturing is increasing or decreasing. More and more it is becoming the custom to estimate "standard" costs before any work is done in the factory, and then to find out, as the work progresses, if these costs are met, and, if not, where improvements can be made. When the actual cost of the product is estimated ahead of time, a check can be made, when the final costs come to hand, to find out whether there is a profit or not. In this way, it is possible to come closer to the actual cost when estimating work than if no accurate records were available; and when costs are excessive, it is possible to fix the responsibility and to find out the reason.

The real purpose of factory records is to furnish danger signals. When the production per man-hour is low, this should immediately be apparent from the records. When too much material is being consumed in proportion to production, records should be available to focus attention on this condition. Records in the hands of an intelligent foreman are the same as tools to an intelligent worker. By the use of these tools, a foreman can increase his output and decrease his costs. Any record that does not show actual operating conditions should not be kept; but as a rule, the more complete the system is, the better, provided it is used properly, as it increases the number of warning signals.

There was a time when the selling price of an article was controlled by the cost of manufacturing it, but today the actual cost of manufacturing is not the only thing that controls the selling price, the principal factor being competition. The sales manager finds out what the buyer is prepared to pay or will pay. With this information in hand, he determines what it will cost the factory to turn out this product. In order to do this, accurate costs must be available. These are obtained from records compiled over a period of time, from which it can be decided whether it is advisable to accept the business or reject it.

The real purpose of factory records is, on the one hand, to furnish standards for measuring performance, and, on the other, to provide danger signals. If there is no standard of performance, there are no means of measuring results from day to day, or week to week, and it is impossible to know at what percentage of efficiency the plant is working. When there is such a standard (which can be set only by keeping proper records) then, if the production per hour, day, or week is low, this will be shown immediately by the records. If too much material is used in proportion to production, properly kept records will focus attention on this condition. Records in the hands of an executive, superintendent, or foreman are like tools in the hands of a workman. By the use of these tools, an executive can increase output and decrease costs.

The Records must be of Practical Value to the Shop

No records should be kept that do not aid in decreasing costs or increasing efficiency. Very often you will find a most elaborate system of accounting in use, requiring a large staff to maintain it, but the value of this scheme of accounting is nil if the facts recorded cannot be made use of by the factory organization.

A bookkeeper or an accountant can develop a system of costs that is acceptable to the board of directors or stockholders, but it requires someone with a knowledge of manufacturing to build up a cost system that can be utilized by a general superintendent or a departmental foreman. No factory cost system is worth anything unless it meets the approval of the factory management and can be readily used by them as a means of comparison.

There are other things besides labor that must be considered. Costs, from a factory standpoint, must include productive labor, material, and burden charges. The reason for burden being included is that, as the production per machine or man-hour is increased, the burden costs automatically decrease. This can best be illustrated by a concrete example.

Two men are working on a piecework job, earning one cent per piece and making one hundred pieces per hour, operating a large power press. The burden charges for this particular press amount to $3 per hour. The production per hour is gradually increased from one hundred pieces to one hundred and twenty-five pieces per hour. In the first case, the total cost per hundred pieces was $4, or 4 cents per piece. In the second case, the labor cost per hour was $1.25 and the burden cost $3, making a total of $4.25 for one hundred and twenty-five pieces, or an actual cost of 3.4 cents per piece. This shows that although the labor cost per piece remained the same, the earnings of the men were increased, while the actual cost to the company showed a decrease of 15 per cent. It is always necessary in comparing or analyzing costs to see that the proper burden charges are distributed so that a true comparison can be made.

Records Keep the Superintendent Informed of the Operation of the Shop

Records are valuable to a superintendent, as they enable him to keep in touch with all departments in the factory, without personally supervising all activities in these departments. A brief summary of the main items covering production and costs will enable him to check the performance of the departments daily.

In many factories all over-time must be passed on by the general superintendent, and quite often, owing to the pressure of other business, he fails to realize the extent of such expenditures. A report on the over-time every morning keeps him posted on such a condition and enables him to control it. This is also true of scrap and rejected material. Any large increase of rejections in any department should come to his attention right away, and should also be brought to the attention of the departmental foreman as soon as it is discovered by the inspector. In some factories, the inspector

must make out a scrap ticket, forwarding a duplicate to the departmental foreman, so that he knows of the condition and can take immediate steps to remedy the trouble. In one factory where this means was used to bring scrap to the attention of the foremen, they finally brought down the value of scrap to less than one quarter of one per cent of the total value of the production.

The Effect of Records on the Organization

The intelligent foreman welcomes cost keeping and records, as it permits him to gage his own efforts. He may think that his department is doing well, but when figures are submitted, he is in a position to know definitely just how well he really is doing. Records will enable him to prove his worth better than a mere statement that cannot be backed up. If he is able to prove that his labor cost per unit was so much when he took charge of his department, and that he has succeeded in reducing this cost, he knows that he has merited financial consideration when the time is ripe for it.

It is true that the dispensing of information to the foremen puts the evidence in their hands, but every fair-minded employer will concede that if a foreman has accomplished certain savings through his own efforts, he is entitled to participate in these savings to a certain extent. And he will have more incentive to continue to increase his departmental efficiency if he is rewarded for savings accomplished. Records will inspire both foremen and men to renewed efforts, as it is only human nature to try to beat the best record.

Foremen Should not be Overburdened by Clerical Work

In some factories the foremen know practically nothing about the cost of operating their respective departments, while in other factories they are compelled to do so much accounting or clerical work that they do not have time to supervise the work of the department intelligently. In many places, the foreman is held responsible for the distribution of all the time of the men in his department, for the setting of piece prices, for specifications for material, and for cost information; and at the same time he is responsible for experiments being conducted with new equipment.

Some general executives feel that by having a foreman do this work they are saving on the cost of clerical work. It is true that they may be accomplishing this saving, but suppose the foreman is responsible for from twenty to thirty other men, and that they each lose half an hour per day due to lack of supervision; then there is a decided loss instead of a saving. Proper records are required, and no factory can hope to compete today if it is not furnished with them, but the foreman cannot supervise the work of the men properly if the greater part of his time is spent in doing clerical work.

When Department Foremen should Keep Records of Their Own

When records cannot be obtained in the proper way, the efficient foreman will develop his own, so that he will be able to satisfy himself as to the results being obtained by his efforts. Of course this takes time that should be devoted to other things, but the only way to run a department intelligently is to know what is going on at all times, and this can only be accomplished by the use of records.

The cost accountant should be responsible for keeping all factory costs and furnishing them to the general superintendent in understandable form. The superintendent, in turn, will see that the various departmental foremen are furnished with the records necessary to run their respective departments intelligently. At the same time, all foremen must keep certain records for their own use.

If a foreman is going to run his department properly, he must know from time to time, during the day, how the production is running. He should be able to strike a fair average in estimating his payroll, and the running time of his equipment should be known at all times, as well as the amount of his supplies. In fact, he should supplement the figures he receives from the superintendent with actual facts which he can gather from day to day, and in this way always be familiar with the conditions in his department.

Many foremen feel that all the knowledge they require to operate their department can be carried in their head. This is a great mistake, as it is surprising how quickly one forgets. It is a good rule, when you have figures of any kind that may be required later, to put them down so they can be referred to at any time; if they are not so recorded, there will always be a doubt regarding their accuracy.

The Value of Records to the Shop Man

By the use of individual production records, the worker gradually becomes acquainted with the possibilities of the job he is working on, and it becomes easier to establish a standard. It is really surprising how many men work all day long, and are not interested enough to learn how much they have accomplished.

Records give the good worker an opportunity to demonstrate his ability, and he feels, on account of his record, that he will be given fair consideration. This may mean the survival of the fittest, when it comes to the time when the force must be reduced, or it may result in an increase in pay, on account of the record that a man has established.

In some factories, the foremen know practically nothing about the cost of operating their departments, while in others, they are compelled to do so much accounting and clerical work that they do not have time to supervise the work of the department intelligently. Some general executives believe that when the foreman does the accounting work, there is a clear saving represented by the wages of a clerk. If, however, each of the twenty or thirty men that may be working under the foreman loses part of an hour each day, due to lack of supervision, it may prove to be a very costly thing to have the foreman doing the work of a cost clerk. No factory can be run efficiently without proper cost records, but the foreman should not be expected to keep these records.

How the Keeping of Records Tends to Reduce Expenses

In a certain factory where there were four 400-horsepower boilers, it was found that there was not sufficient steam to care for all the requirements. A new lay-out was submitted, showing an addition to the boiler house and the installation of two new boilers. The appropriation had actually been provided before the management decided to install flow meters and measure the steam used by the various departments. Just as soon as the departmental foremen knew they were being checked up, they immediately found ways and means to save steam which had never been thought of before. The result of this was that, instead of purchasing new boiler equipment, the factory management found that there was sufficient capacity on hand, and one boiler could be shut down and held as a spare. Similar conditions exist in many places, and these are brought to light whenever you begin to check up or keep records.

It is only natural for a foreman to keep within his department all the tools and gages needed to perform the work in that department. He is not interested in any other department that may be held up because there are no air drills or other tools or equipment. An accurate record should, therefore, be maintained of the tools and equipment issued to every department in the shop, and periodically—for instance, once a week or once a month—every tool should be rounded up and checked in.

In one factory, it was decided that twelve new air drills were required, as production was being held up due to lack of this equipment. Finally it was decided to have every foreman turn in all the air tools that he had in his department. The result was that it was found unnecessary to purchase new tools; in fact, after satisfying every department

in the factory, there were still eight tools left in the tool-crib. The value of an accurate record is well demonstrated in this case, and the same is true of all kinds of portable equipment.

Make Sure that the Records Compiled are Properly Understood and Used

Records, however, must be used, not just accumulated. The man who compiles the records that are used in the factory, should also be able to explain them to any foreman or workman when called on to do so. He should have such a knowledge of the factory and of the different operations that he can talk intelligently on any set of actual facts represented in figures, and make it plain and understandable.

Records can be used in many ways, either by giving the information directly to the foremen or the men, or by posting it so that all interested may see what has been accomplished. A record of scrap can be sent out in the form of a general notice, showing how the different departments line up, giving the pieces of scrap and the value, and the department responsible for the scrap. No foreman wishes his department to be the worst offender, as it is recognized that scrap is an actual loss.

Knowing that records are made of all their supplies, some foremen are likely to hold these down to absurd limits. One foreman, who had his attention drawn to the amount of waste used in his department, solved this difficulty by refusing to allow waste to any of his men. The result of this was that his men found ways and means of stealing from other departments. Such extremes must be prevented. Records should be kept of all supplies, tools, and material used, and a check made from time to time to see that there is not an excessive amount of this material used; at the same time, it should be made sure that sufficient supplies are being given to the men.

No records should be kept that do not aid in reducing costs or increasing efficiency. Frequently elaborate systems of cost accounting are found, requiring a large staff to maintain them, but which have little value because the facts recorded are not presented in a form that can be used to advantage in the factory. On the other hand, properly presented records are very valuable to a superintendent and should enable him to keep in touch with what is going on in all the departments of the factory without personally supervising all the activities in these departments. A brief summary of the main items covering production and the factors that influence cost will enable him to check the work of each department daily.

A Unit of Comparison is Necessary in All Cost Records

Records must be easily understood and practical to be of use to a factory organization. When we purchase meat at the butcher shop, we are interested in the cost per pound—not in the cost per cubic inch. When we buy oranges we want to know the cost per dozen. So it is with factory records—they must be in such form that a true comparison can be made; otherwise they are useless. If a foreman wants to know his labor cost per ton of production, or per unit of production, then all other costs in his department must be referred back to the same unit, so that comparisons can be made. No comparisons can be made of production per man in tons, supplies per machine in operation, and tools per thousand pieces of different kinds. To handle records intelligently and get the most from them, the departmental foreman wants his cost per unit of product, supplies per unit of product, and tools per unit of product. Steam, power, and other items that go toward increasing costs in his department must also be per unit of product. Then costs can readily be compared and controlled.

Effect of Records on Accidents, Power Consumption, and Other Items

It is only lately that employers have realized that the best possible way of preventing accidents is to furnish all foremen with an accurate record of the accidents in their departments and an estimated cost of them. Many foremen do not realize that an injury to a man in their department actually increases the cost of production in the department.

In many factories the power to different departments is metered, so that the foremen may know what power they are consuming, and this is checked against the production to show whether there has been any needless power consumption. There are factories where every bolt, nut, and screw obtained from the store-room must be requisitioned, and this requisition countersigned by a departmental foreman before the supplies can be obtained; yet these departments will be consuming $50 worth of power per day, and no accurate check is made of it.

There are other ways in which the cost of production may be increased, which are beyond the control of the factory organization and which come under the jurisdiction of the production manager. Carrying too much stock, either of finished or unfinished material, ties up capital, and this costs money. On the other hand, too little stock may be carried, so that the departments are held up waiting for material. There should be a perpetual check made on the stock to see that it is kept within the proper limits, and this can only be done through accurate records.

Compiling Records when the Need for them has Passed

It is a good scheme to check up on the various records from time to time to see that they are all being used. Quite often a record is requested for a period of a few months, and this record is maintained for years, without anybody paying any attention to it. There are men who spend their whole lives compiling figures that are never looked at. Hundreds of records may be kept which are of no value; on the other hand, hundreds of records may be kept which tend to increase factory efficiency. The test of a record is this: What does it accomplish in cost reduction?

How to File Records

In all large organizations, there should be a library, or some place where records can be filed, so that they may be easily available. These records should be in charge of someone who will see that they are properly maintained. It is quite a common occurrence to find three or four copies of the same records in different offices in a factory. If there is a central location for all reports, there will not be any need for duplication.

The person in charge of such a department can also mark periodicals that contain items of interest and forward them to different men in the organization. Information of all kinds should be made readily accessible, and this can only be done by some central means of distribution.

It should be remembered that records, as a general rule, cover past performance. In practically all factories, conditions are analyzed which have existed weeks before. From the factory standpoint, records, to be of any service, must be "live," and must be in the hands of the factory organization as soon as possible after the events they are recording. Old records can show where costs were in excess of what they should have been, but so many events have happened since that time that they are practically useless. Records, to be of value, must reach the factory organization while the conditions are still in mind.

* * *

The eighth British Industries Fair will be held at Birmingham, England, February 21 to March 4, 1927. The area of the exhibition buildings, all under one continuous roof, measures nearly 200,000 square feet. The fair is open only to British manufacturers, the exhibits being divided into eleven representative groups, covering all branches of engineering. The British Government has agreed to spend a sum not to exceed $120,000 for the purpose of publicity in Great Britain and abroad.

Rapid Drilling and Tapping on Multiple-Spindle Machines

By O. R. RELLER,* Moline Tool Co., Moline, Ill.

THE rapidity and accuracy with which duplicate drilling operations can be performed on multiple-spindle machines depends largely upon the design of the jigs or fixtures employed. Many difficult drilling operations that have long been the bugbear of production managers have been placed on a satisfactory production basis by employing multiple-spindle drilling machines equipped with suitable jigs, fixtures, or special tools. However, the wide range of adaptability of machines of this type is not generally realized. It is the object of this article to give some idea of the rapidity with which various kinds of drilling operations can be performed on properly equipped machines.

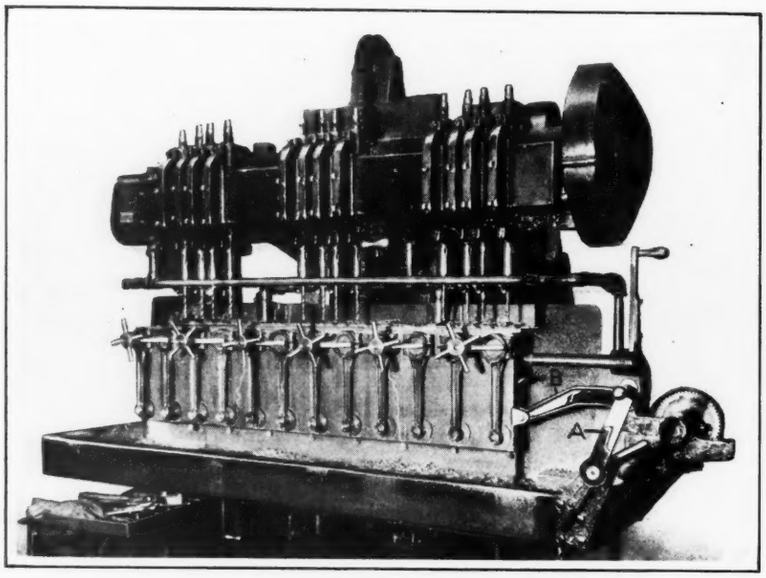


Fig. 1. Multiple-spindle Machine equipped for drilling Connecting-rods

Referring to the accompanying illustrations, the tables on which the special jigs or fixtures are mounted are raised or fed upward by cams designed to meet the requirements of each individual job. This feature provides for the rapid advance of the work to the drills and allows the table to be dropped quickly after the drilling operation is completed. The special jigs and fixtures described, and the machines on which they are used, were made by the Moline Tool Co., Moline, Ill.

*O. R. Reller was born in Vincennes, Ind., in 1888. After having graduated from the Evansville High School in 1907, he attended the University of Cincinnati, taking the cooperative engineering course. During this course, he spent half of his time in the employ of the Cincinnati Bickford Tool Co., thoroughly learning the machinist's trade while gaining his engineering education. Later he was foreman of the drilling department of the Cincinnati Bickford Tool Co. for two years. Twelve years ago he became connected with the Moline Tool Co., Moline, Ill., first as foreman of the assembly department, and then gradually taking up engineering work in various capacities.

Drilling Connecting-rods

In Fig. 1 is shown a twelve-spindle machine equipped for drilling, simultaneously, two 29/64-inch holes in six connecting-rods. It will be noted that the fixture holds twelve connecting-rods, and through lever *A* and link *B* it is slid over into position for drilling six of the connecting-rods that are

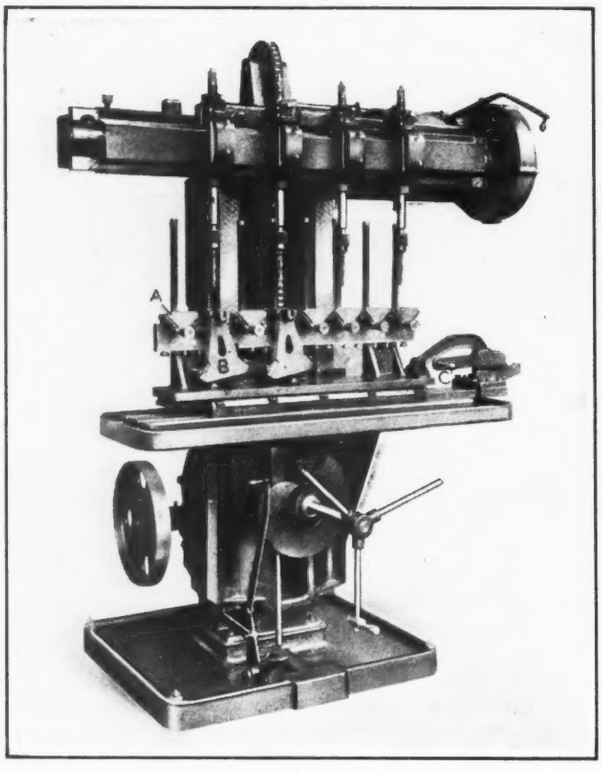


Fig. 2. Sliding Jig that holds Two Large Castings and Six Small Ones

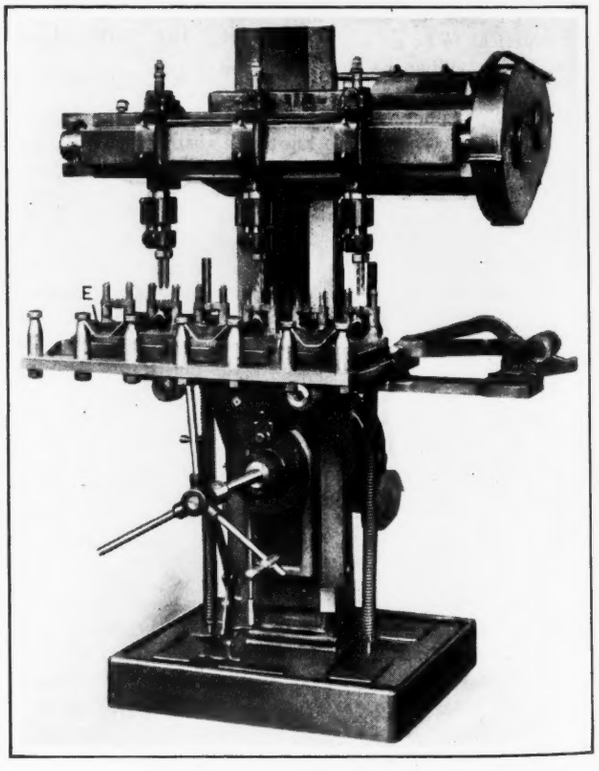


Fig. 3. Jig for simultaneously drilling Two Holes in Three Parts

placed in the fixture while the drilling operation is being performed on the other six rods. This machine is installed in the plant of the Nash Motors Co., Kenosha, Wis. The production rate obtained is 180 rods per hour.

Drilling Washing Machine Parts

In Fig. 2 is shown a four-spindle machine equipped for drilling 7/16-inch holes in castings used in the construction of washing machines. In this particular case, three small castings *A* are required for each large casting *B*. In order to maintain the required production ratio between the large and the small castings, the work-holding fixture is designed to hold two large castings and six small castings.

On the first upward feeding movement of the table, two large and two small castings are drilled. The table is then drawn down and slid into the second drilling position by means of handle *C*, after which the four remaining small castings, like the one at *A*, are drilled. By this method, the alternate stations can be loaded without interrupting the drilling operations at the working stations, thus keeping the machine in practically continuous operation.

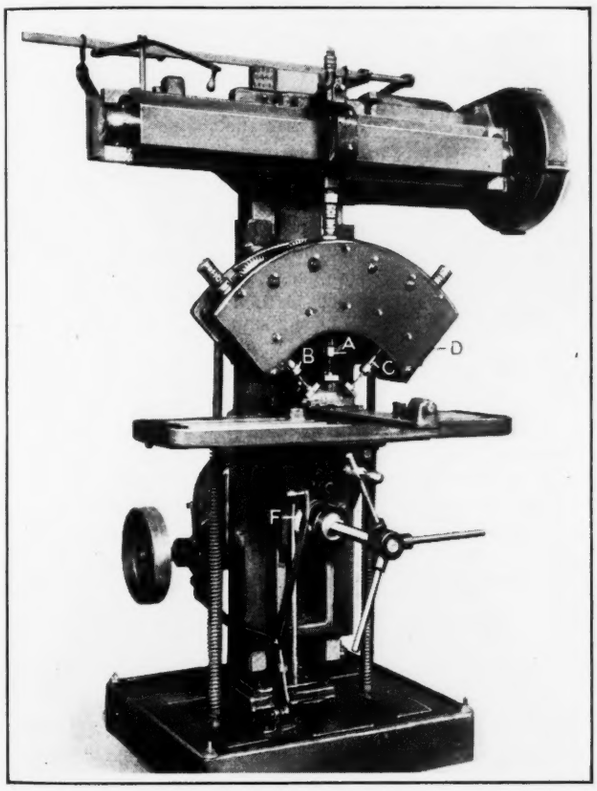


Fig. 4. Machine equipped for drilling Three Holes along Radial Lines 45 Degrees Apart

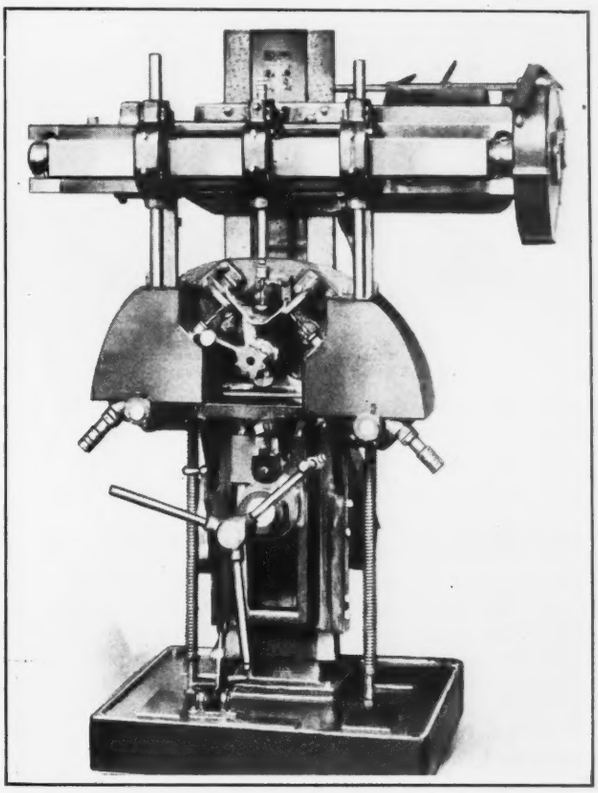


Fig. 5. Machine equipped for Drilling Operations Similar to those performed on Machine shown in Fig. 4

The clamping of the castings is all done by spring-actuated clamps, and the feeding movement of the table is obtained by means of a cam. By the installation of this machine, the production per hour was increased from 200 to 1240 castings. The machine shown in Fig. 2 and those shown in Figs. 3 and 4 were installed in the plant of the Maytag Washing Machine Co., Newton, Iowa.

In Fig. 3 is shown a multiple-spindle drilling machine equipped for simultaneously drilling two 3/8-inch holes in three washing machine legs. The sliding jig is designed to permit three pieces of work to be drilled while three undrilled parts are being loaded in the jig.

Drilling Holes at Angles

Referring to Fig. 3, it will be noted that there are three faces or flat surfaces at the end *E* of the washing machine leg. To complete the drilling operations on these pieces, it is necessary to drill a 17/64-inch hole through each of the three faces at the end *E*. The included angle between two of the adjacent flat surfaces is 45 degrees, and in order to drill the three holes simultaneously, it was necessary to provide a drilling machine with three spindles located in the required angular positions, as shown in Fig. 4. In this installation, the vertical spindle *A* is driven by the standard spiral gear arrangement. This spindle has no vertical movement, but drives the spindles *B* and *C* through bevel gears mounted in the head *D*, which moves with the work-holding table.

When the machine is in operation, the cam *F* feeds the table upward, bringing the drill in spindle *A* in contact with the work. On the vertical spindle is located a quill having a rack cut on opposite sides. The racks mesh with spur gears mounted on the same slide with the table. When the table is fed up against the drill in the central spindle, the spur gears, being in mesh with a stationary rack, are forced to turn, and this movement is transmitted to similar racks on the end spindles *B* and *C*, causing them to be fed inward.

The drills are thus fed in along center lines spaced 45 degrees apart which intersect at a common point. It will be noted that drill guide bushings are secured to the work-holding fixture and that the work-holding fixture is shown without a piece of work in place. The production obtained with this machine is 300 drilled pieces per hour. In Fig. 5 is shown another multiple-spindle machine, which is similar in operation to the one shown in Fig. 4. The principal difference in the design of these machines is that the one shown in Fig. 5 has the outer spindles arranged to feed upward, and they obtain their drive from individual driving heads.

Tapping Flanges on Multiple-spindle Machines

In Fig. 6 is shown a multiple-spindle machine equipped with a tumbler type of jig for holding 2-inch pressed-steel flanges. The pressed-steel flanges are located and held in position by grooves cut into blocks *A*. The tumbler jig is automatically indexed after each set of four flanges is tapped. The flanges are placed in the slots in the locating blocks on one face of the fixture while the taps are in operation. Small pins, like the one shown at *B*, serve as stops for centering the work. As the face of the jig carrying the tapped flanges is indexed around to the back position, the work drops from the slots, and slides down the sloping sur-

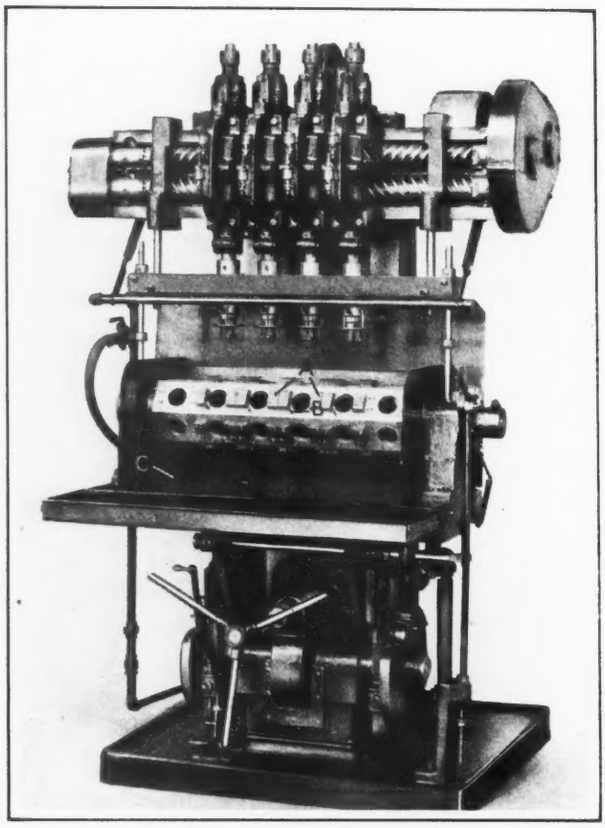


Fig. 6. Four-spindle Machine equipped with Taps and Tumbler Jig for tapping Pressed-steel Flanges

face of the sheet-metal pan *C*. This machine, which was built for the American Flange Co., Chicago, Ill., gives a production of 1000 tapped flanges per hour.

* * *

PROPOSED MUSEUM OF PEACEFUL ARTS

According to information furnished by the office of the proposed Museum of Peaceful Arts, Room 917, Engineering Societies Building, 29 W. 39th St., New York City, substantial progress is being made with the plans for a great industrial and technical museum to be established in New York City, as financed through the will of the late Henry R. Towne. Dr. George F. Kunz is president of the proposed museum and Calvin W. Rice, honorary secretary.

The first section of the museum to be installed will probably be that on machine tools and shop practice. This follows the suggestion of Mr. Towne that the museum initiated by his bequest cover this field first, as it is fundamental to all the other industrial arts. Joseph W. Roe, professor of Industrial Engineering at New York University, and author of "English and American Tool Builders" and other books dealing especially with this subject, is acting as adviser to the machine tool group. He has already actively interested a number of American manufacturers of machine tools in the plans. The machine tool section of the museum will be introduced by a series of period rooms.

There will be a series of old shops fitted up with machines, tools, lighting, shafting and so forth, with life-sized costumed manikins shown engaged on the products and using the methods typical of the periods from Colonial times to the present day. In this way, the relative age of the different types of machinery, and the conditions under which the work of the old mechanics was done, will be brought out. These rooms will be followed by a series of models and originals showing the development of elements of machines and the major types of machine tools and standard production machinery. Machine tools are largely combinations of a few standard elements, such as cutters, screws, gears, slide rests and the like, which appear in many types of machines. Each of these elements has a technique of its own, and the purpose is to show its history from primitive forms down to the latest practice.

Machine tools as a whole will be grouped by major types, such as lathes, milling machines, gear cutters, drilling equipment, etc. It is planned to show the history of each type, through the significant stages, down to the best current practice; and to bring out the kind of work for which each type is adapted and the reasons therefor.

The plans include a library for students and technicians as well as for the layman, or rather for a section library for each group, placed on the exhibition floor in close proximity to its section. Labels will refer to volumes in which an interested visitor may carry on his research.

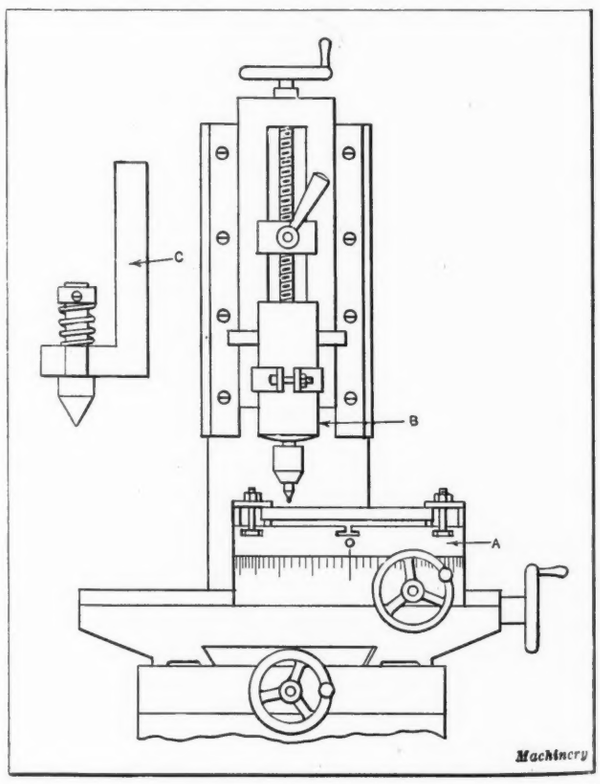
* * *

DRILLING ACCURATELY SPACED HOLES ON THE SLOTTER

By CHARLES KUGLER

Having experienced considerable trouble in drilling evenly spaced holes in jigs and dies by the usual methods, a vertical slotter was finally equipped as shown in the accompanying illustration for this work. The portable electric drill shown at *B* was secured to the tool-holder, with the spindle carefully trued up at right angles with the surface of the table *A*. This arrangement served as an excellent precision drilling machine with cross-slides that could be accurately positioned by the micrometer feed-screw dials. The revolving table, which was graduated in degrees and fractions of degrees, provided means for spacing holes evenly around a circle or on lines at any required angle.

When large holes are to be drilled, the center-punch *C* is clamped in the toolpost, and the same methods employed to locate the punch as are used when drilling small holes. After properly locating the work under the center-punch, a hammer blow on the head of the punch produces the required center mark in the work. Holes located in this manner can be bored either in a lathe or milling machine, after first truing up the center mark with an indicator or tester in the usual way. While it is not claimed that as accurate results can be obtained by the method described as by the button method, the work turned out has proved to be very accurate, and is more rapid than the button method.



Slotter equipped with Drill for drilling Accurately Positioned Holes

The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, June 16

THE metal-working industries have shown only a minimum of activity since the general strike. For some weeks before the strike was called, there had been a noticeable and fairly general slackening of inquiries. The prospect of the cessation of the coal subsidy on May 1 was sufficient to account for this falling off in business, especially as it was impossible to foretell the character or extent of the trouble that would follow. The cessation of the general strike left the coal dispute where it was on May 1, and no coal has come from the pits for over a month.

Generally the amount of motor transport now available has overcome some of the immediate effects of the coal shortage. The railways are running 50 per cent service. The London Midland & Scottish and the Southern groups have already taken the necessary steps for oil-firing their locomotives, and the next few days will see many engines equipped for burning oil. Oil-firing on railways has had no extended trial as yet, and the result will be watched with considerable interest. Users of town's electric power are being supplied with only half their normal current. England is one of the few countries that continue to burn large quantities of soft coal in its natural state, and the treatment of coal for the production of other forms of fuel and the recovery of by-products was considered very fully by the Coal Commission. One of the results of the Coal Commission's report will undoubtedly be a great speeding up of fuel research.

It is generally felt that when a settlement has been reached in the coal fields, industry generally will be undisturbed by any serious strikes for a long time to come. Although engineering workers were not called out as a whole during the general strike, the industry suffered severely. Business dwindled away to almost nothing, and material was extremely difficult to obtain. There is an almost complete stoppage of large orders in every branch of engineering, and it is probable that very little business will be done until the coal trouble is overcome.

Machine Tool Industry

Considering general conditions, a fairly satisfactory inquiry is being maintained for machine tools. In the Midlands, manufacturers of turret lathes and screw machines have a good deal of work in hand, while in Yorkshire, makers of hydraulic tools and presses are fairly busy. In the Manchester area, firms making planer type milling machines, grinders, and screw machines are well occupied, but generally shops engaged on machine tools have very little work.

Overseas Trade in Machine Tools

The overseas trade in machine tools during the last three months was as follows:

	February	March	April
Exports, tons	1595	1302	1213
Imports, tons	594	901	511
Exports, value	£170,190	£145,054	£128,347
Imports, value	£57,246	£98,039	£78,053
Exports, ton-value	£107	£111	£106
Imports, ton-value	£96	£109	£153

These figures show a distinct falling off in both tonnage and value of exported machine tools during March and April, although the average tendency over the last twelve months is upward. Imports, while experiencing a decline in April, show an upward tendency during the last twelve months that is much more pronounced than that shown by exports. The exports of machine tools are now about equal in tonnage to pre-war figures, but import tonnages show more than a doubling of pre-war business.

General Engineering Field

Builders of heavy electrical equipment maintain the steadiness in activity that has characterized this branch of industry for the last two or three years. Orders for locomotives continue to be received in small batches for both home and foreign service, and railway rolling stock orders are keeping all the important firms in this line busy. There are also some valuable orders in hand for electric street cars for Manchester. Textile machinery business is stagnant.

Shipbuilding

Shipbuilding showed every sign of revival before the general strike; work in the yards did not cease, and local engineering and shipbuilding workers in the district did little to support the general action of the trade unions. The falling off in foreign trade during the strike will, however, have its inevitable effect on the shipping trade, and therefore on the shipbuilder.

Since the strike there have been few signs that the improved position reached during March and April will be recovered immediately. However, the outlook is very hopeful, and with an early settlement of the coal dispute, shipbuilding is likely to be in an immeasurably better position at the end of this year than for many years past. The majority of the bigger yards on the Clyde and elsewhere have somewhat more than the usual amount of repair work in hand.

Iron and Steel Field

Pig iron is being bought only in very small quantities for the home trade, and the export trade is at a standstill. Large numbers of blast furnaces have been shut down, and will not be relighted until a settlement has been reached in the coal mines. Iron production has practically ceased, and stocks are being steadily if slowly depleted. Prices generally are up by two or three shillings per ton.

In Sheffield, the lack of adequate fuel supplies is holding up not only existing business, but the placing of new orders. There are 15,000 more operatives idle than before the general strike, bringing the total of unemployed in this district up to 37,000. The business being transacted is small, because of the uncertainty of the iron and steel position. Buying of raw materials is confined to small lots, owing to the artificial values prevailing. The lighter trades have resumed business at a reduced capacity. Some of the big steel plants with important orders in hand are getting under way again. In some instances, big stocks of coal are held and in others, the fuel is being brought from the stocks at the pit heads in the district by motor trucks.

* * *

MACHINERY TRADE IN FRANCE

Statistics published by the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, Washington, D. C., indicate that there was a slight falling off in the imports of industrial machinery to France during 1925, the tonnage in 1924 being 53,442 tons as against 52,977 tons in 1925. It is of interest to note that, in spite of this decline in the volume of industrial machinery imports, the exports of industrial machinery from the United States to France increased slightly. Germany and the United States were the principal suppliers of machine tools to the French market in 1925, Germany furnishing one-third, and the United States, one-fourth, of the total imports. The French exports of machine tools in 1925 increased 30 per cent over the previous year.

Current Editorial Comment

in the Machine-building and Kindred Industries

SHOP VISITS ARE HELPFUL

Many industrial plants have found that it pays to afford their designers and foremen an opportunity to visit other plants and get ideas of their methods and operation. In the automobile industry, particularly, this custom has been quite common. Visitors from other plants are welcome, and information usually is exchanged freely. Recently the same practice has become prevalent in the railroad industry, some of the roads giving their superintendents and foremen an opportunity to visit the shops of others. The broadening influence of this practice is beyond question to men capable of observing new methods and absorbing novel ideas as they pass through a shop, and applying what they have seen to their own work. One good idea applied in this way will pay for the time and expense of the visit.

In the machine tool and shop equipment industries, such visits probably would be most profitable if devoted to a study of the conditions and methods in customers' plants. A machine tool designer who has seen the methods of operation in some of the leading automotive plants certainly would be better able to design machinery for that industry than if he had not seen how the work is actually done. The conditions of operation in an automobile plant and in a machine tool shop are so different that his imagination alone is not capable of providing the ideas required to improve on the equipment in the high-production shop. For the same reason, designers of machine tools and other equipment intended for railroad shops should have an opportunity of actually visiting such shops. They would acquire a broader view of railroad shop needs and a better appreciation of the difference between equipment for repair and production work.

The shop visits frequently arranged in connection with conventions do not meet the need of the machine tool designer as well as an individual visit, because it is difficult to gather much real information when one is conducted through a plant with a large number of other men. The best way is to arrange for such shop visits by correspondence, so that the visitor will meet the right men when he arrives, and without waste of time have an opportunity to see the operations or appliances that will be helpful in his work. Most plants are willing to cooperate with machine tool manufacturers in this way and to give their representative an opportunity to study the needs of the industries that use machine tools. The advantages derived are usually mutual.

* * *

MISUSE OF WRENCHES

Many machinists do not realize that a nut can be tightened so firmly that the holding power of the bolt is thereby reduced considerably. If a wrench has a handle long enough, it is possible to continue tightening the nut until either the bolt twists off or the threads are stripped. But long before the bolt shows signs of weakening, or the threads of stripping, the bolt may have been subjected to a stress that has reduced its strength so that it cannot sustain the load placed upon it when the mechanism is at work. It is important to remember in tightening nuts, therefore, that the use of wrenches with unusually long handles is inadvisable. Do not put a pipe on the end of a wrench handle to obtain additional leverage for tightening a nut more securely. A nut should be tight—no more. If it is forced beyond that point, the resisting power of the bolt and its threads is reduced, sometimes to a point where a serious accident may result.

PLANNING SCREW MACHINE WORK

In scheduling shop work for different machines, considerable savings can be made by careful planning. For example, in assigning work to automatic screw machines, it is possible, by grouping successive jobs for each machine, to reduce the time for camming and adjustments to a minimum. This is done by arranging for similar parts to follow each other on the same machine so that possibly only one or two adjustments need be made for a new part. A careful estimate should be made of the most economical number of parts to be produced at one set-up. "The most economical number" is determined by balancing the cost of carrying parts in stock against the cost of the time required for setting up the machine. In one large plant having an extensive screw machine department, it was found possible to increase the efficiency of this department 20 per cent by the grouping of similar jobs and by a careful study of the number of parts to be made at each set-up.

* * *

SAVINGS EFFECTED BY REDESIGNING

In many instances savings are made possible in the shop by redesigning the product so that the machining work may be simplified, and this applies not only to the machine shop, but to the pattern shop and foundry as well. Sometimes, two parts that formerly were slightly different because they were used on different models or in different places on the same machine, may be made alike. Again, the shop work may be simplified by making a piece in two parts and joining them afterward by welding, riveting, doweling or other means. In other cases, a saving can be effected by the reverse process—making in one piece, parts formerly made as two separate units.

The men in the shop responsible for production are more likely to know where savings can be made in machining than are the designers, and suggestions from the shop should be encouraged by the engineering department. If foremen and tool engineers are encouraged to suggest simpler and cheaper methods of production, through simplification in design, they will often submit to the engineering department for approval ideas that otherwise would never be discussed. The engineering department, of course, should think first of the quality of the product and should not sanction any changes, no matter how meritorious from a production point of view, unless the quality of the product can be maintained; but often the cooperation between the designing engineers and the production department heads will result in changes that not only reduce production costs, but actually improve the design. In an automobile plant, a change recently made in steering gear parts, through the cooperation of the shop and the engineering department, saved 27 per cent of the cost of production.

A change in the design of the connecting-rod of a well-known automobile not only simplified production methods, but actually improved the product. Formerly this connecting-rod was provided with an outside tube for lubrication; now, a hole is drilled through the center of the rod, which greatly improves the design and, in addition, saves at least half an hour's time on every connecting-rod made.

Similar instances will occur to most mechanical men engaged in shop work. Those mentioned are sufficient to illustrate the results of cooperation between the designer and the shop man when they work harmoniously together and freely consider suggestions from each other.

Hypoid Gears*

By ARTHUR L. STEWART and ERNEST WILDHABER, Gleason Works, Rochester, N. Y.

HYPOID gears are tapered gears with offset axes. In general, they look like spiral bevel gears, which they will, in many cases, replace. The tooth action of hypoid gears combines the rolling action of spiral bevel gears with a percentage of endwise sliding. The chief advantages of hypoid gears are noiseless operation, increased load-carrying capacity, the possibility of high reduction and low numbers of teeth, long life, and high efficiency.

Fig. 2 illustrates a pair of hypoid gears, having thirteen teeth in the pinion and sixty-four teeth in the gear, and Fig. 3 shows, for comparison, a pair of spiral bevel gears with the same numbers of teeth and the same diameter of the gear. The most striking difference between the two pairs is the offset of the pinion axis from the axis of the gear, on the hypoid pair. Another marked difference is the increased size of the hypoid pinion, as compared with the bevel pinion; furthermore, it is noted that the tooth inclination on the hypoid gear, or its spiral angle, is small, while the spiral angle of the hypoid pinion is as large as or larger than the spiral angle of the bevel pinion. These differences all have an influence on the performance and the characteristics of hypoid gears, as will be discussed later on.

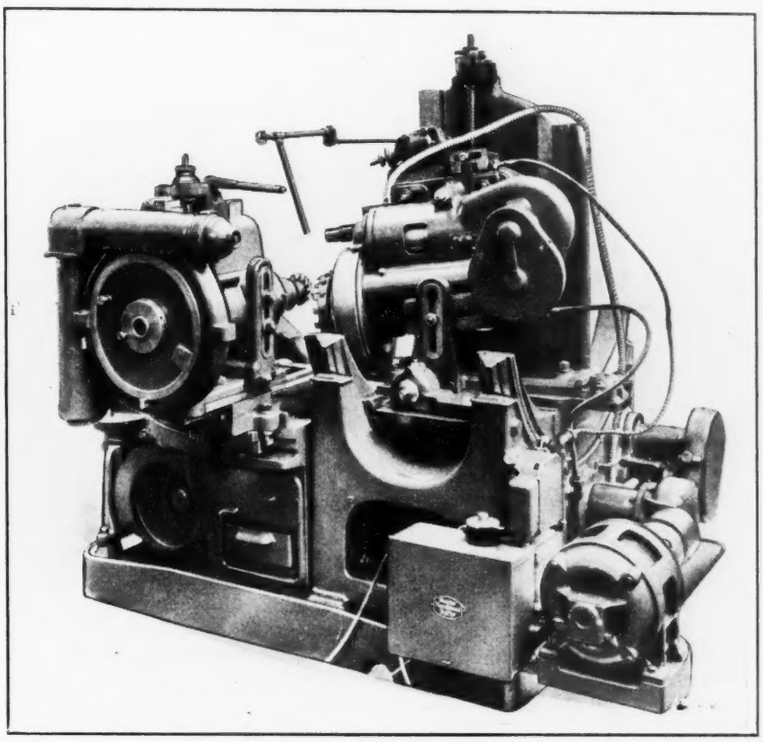


Fig. 1. Gleason Generator for cutting Hypoid Pinions

Names prominently connected with prior developments of hypoid gears in the last decade are those of H. D. Williams, G. M. Bartlett, R. M. Uhlmann, Reginald Trautschold, and Nicola Trbojevich. The new developments made at the Gleason Works comprise new tooth shapes for hypoid gears, as well as new methods of production, and are covered by a series of pending patents.

The Offset of Hypoid Gears

The axis of the pinion is offset from the axis of the gear by an amount that varies with the diameter and the ratio. Standard amounts of offset of 1 1/2, 2, 2 1/2, 3 and 3 1/2 inches are in use. The direction of offset determines the hand of the spiral. In rear-axle design, a pinion below center will have a left-hand spiral, while a pinion above center will have a right-hand spiral. The position below center is preferable for two reasons. First the axial thrust resulting on the pinion on a forward drive is directed away from the gear, and heavy loads tend to move the pinion out of mesh rather than draw it in. Second, the contact between mating tooth surfaces is more intimate on the drive side. This quality is more pronounced on ratios such as are used on pleasure cars than on the larger ratios used on trucks. Objections to the above-center position of the pinion, as far as end thrust is concerned, can be entirely eliminated by making the bearing and housing arrangements sufficiently rigid to prevent the pinion from wedging into the gear.

The offset of the axes is the cause of a certain amount of endwise sliding in the teeth, although such sliding is comparatively small. The teeth of hypoid gears should extend lengthwise along such lines as to permit this sliding. Hence, the pitch lines of hypoid gears are subject to restrictions, that do not exist on bevel gears. The sliding action is sufficient, in addition to the overlapping feature already existing in spiral bevel gears, to produce the degree of quietness in operation that is an outstanding factor in hypoid gears. For the same reason, hypoid gears can be lapped very well and rapidly, and they have a very high efficiency.

Ratio of Diameters

It is a well-known fact that in a pair of helical gears set at right angles, or in a worm and wheel, the pitch diameters do not have to be in the exact ratio of the respective numbers of teeth. In consequence, the circular pitch is generally different on the two members of a pair, and only the normal pitch is equal. The same holds true for hypoid gears. The circular pitch of the pinion and the circular pitch of the gear are proportional to the corresponding peripheral movements. Their ratio equals the inverse ratio of the cosines of their spiral angles. The hypoid member with the larger spiral angle contains the larger circular pitch. The pitch diameters themselves are proportional to the circular pitch and to the number of teeth. The spiral angle of hypoid pinions is being made 35 degrees or 40 degrees, depending on the tooth number in the pinion, while the spiral angle of the gear is being kept around 5 to 15 degrees.

In consequence, the average pitch diameter of a hypoid pinion is increased over the average pitch diameter of a corresponding bevel pinion by 20 to 30 per cent, the gear diameter being the same. This naturally increases the strength of the hypoid pinion. Moreover, it is possible to use large ratios with hypoid gears—ratios difficult to obtain with the spiral bevel gears, on account of the prohibitively small pinion diameters. Larger percentages of diameter increase than those given may be obtained by increasing the spiral angle of the pinion. At a 10 to 1 ratio, a hypoid pinion of 1.75

*Abstract of a paper presented at the summer meeting of the Society of Automotive Engineers at French Lick Springs, Ind., June 1 to 4.

inches pitch diameter may be made to mesh with a gear of 10 inches pitch diameter, while a corresponding bevel pinion would have a pitch diameter of only 1 inch.

Tooth Loads

In computing the tooth loads of a pair of hypoid gears, the circumferential or tangential tooth load P of the gear at the center of the face may be determined from the known torque, and the pressure P_n or load normal to the tooth surface is then determined by dividing by the cosine of the normal pressure angle a and by the cosine of the spiral angle hg of the gear. Thus

$$P_n = \frac{P}{\cos a \times \cos hg}$$

This amount P_n is the total tooth load, or, in other words, the resultant of all components. It is noted that this total tooth load is only slightly larger than the effective circumferential or tangential tooth load P of the gear, for if we introduce as average amounts $a = 17\ 1/2$ degrees and $hg = 8$ degrees, we obtain:

$P_n = 1.06\ P$ — an increase of 6 per cent

In spiral bevel gears, the total tooth load P_n is considerably larger than the effective tangential tooth load. If a pressure angle of 17 1/2 degrees and a spiral angle of 35 degrees is assumed, the total tooth load is as follows:

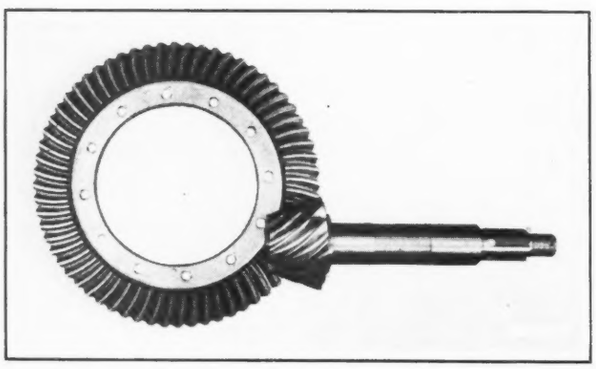


Fig. 2. Hypoid Gearing having Gear of 64 Teeth and Pinion of 13 Teeth—compare with Spiral Bevel Gearing shown in Fig. 3

$P_n = 1.28\ P$ — an increase of 28 per cent, as compared with 6 per cent for hypoid gears.

The Tooth Profiles

The analysis of the tooth profiles of hypoid pairs is somewhat tedious, and cannot be carried out in a single plane. All hypoid pinions have the feature in common, that the tooth profile of one side is more curved than the tooth profile of a corresponding bevel pinion, and that the tooth profile of the other side is less curved or flatter than the profile of a corresponding bevel pinion. Taking the average of opposite tooth profiles, it may be stated that on hypoid gear pairs in general, the tooth profiles are similar to those of spiral bevel gears.

Opposite tooth profiles of hypoid pinions are, however, differently curved. The concave tooth side of a hypoid pinion contains a flatter profile than the convex tooth side. Partly on account of this difference in curvature, the different pressure angles of 17 1/2 degrees and 20 degrees are being used on the drive side and the reverse side, respectively, of the pinion teeth, that is, on the concave and the convex sides of the teeth.

In hypoid gears, the intimacy of tooth contact is substantially the same as in spiral bevel gears, taking the average of opposite tooth sides of hypoid gears; but comparing pairs of equal diameter of the gears, the total tooth load on hypoid gears is considerably smaller than on spiral bevel gears. Moreover, the tooth height, being at a constant proportion to the normal pitch, is larger. Because of these two factors, hypoid gears are able to carry a considerably larger load under equal surface stresses, as compared with spiral bevel gears or straight-tooth bevel gears.

Production of Hypoid Gears

Two different types of tooth shapes and two corresponding methods of production have been developed by the Gleason Works. The earlier method consists in forming the gears without generation. A tooth space of the gear is then the exact complement or counterpart of the cutting surface of the tool. According to a general law of gearing, the tooth surfaces of one member of any pair of gears may be assumed at will, and the tooth surfaces of the other member are then determined or generated to suit the tooth surfaces of the first member. This is done by setting a cutter on a generating machine in such a way that it covers and represents a tooth side of the hypoid gear, and by providing the same relative motion between the cutter and the pinion blank that exists when the pinion meshes with its mating gear.

The earlier method, in which the gear is cut without generating roll, is theoretically accurate; that is to say, it does not contain the least theoretical error or approximation. This method has now been discontinued in favor of another method, which gives just as good or better results on account of its increased flexibility, and which incidentally permits the use of the present generators on the gears. This method is very practical in operation, and permits of refinements not previously available.

A hypoid gear is cut exactly like a spiral bevel gear of the same pitch angle. In the production of the pinion, a Gleason

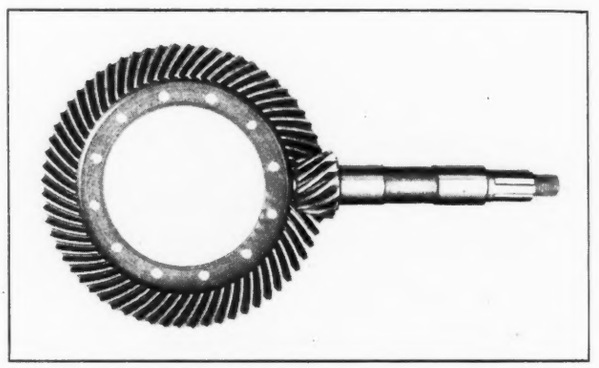


Fig. 3. Spiral Bevel Gearing having Gear of 64 Teeth and Pinion of 13 Teeth—note Size of Pinion as compared with that in Fig. 2

generator with additional adjustments is used, and the pinion axis is offset from the axis of the cradle. (See Fig. 1.) The cutter is of the usual Gleason type, having straight cutting edges which are at an angle to the axis of the cutter. Preferably, different cutters are used on gear and pinion. One gear cutter and one pinion cutter can cover all cases. It is not necessary to use cutters with varying amounts of pressure angle correction, as has been the practice with spiral bevel gears. During the generation, the cutter represents a crown gear with an offset axis, and conjugate to the same pinion which is also conjugate to its known mating gear. A generating motion is provided between cutter and pinion blank as if the pinion were rolling on the crown gear.

Bias bearing, or a tooth bearing that extends obliquely across the tooth surface, which has been found objectionable in certain cases of curved tooth gearing, results when the pressure angles of gear and pinion do not match along the whole length of the teeth. The pressure angles of hypoid gears are made to match along the whole length of the teeth, and bias bearing is thus entirely eliminated. Another feature illustrating the flexibility of the method of cutting is the fact that the tooth bearing of a pair of hypoid gears can be raised or lowered, or moved endwise, by simply changing the cutter setting. If it is desirable, for instance, in order to counteract hardening changes, the tooth bearing can be placed readily on any desirable spot on the tooth surface.

Production operations are, in general, the same for hypoid gears as for spiral bevel gears. This includes preparing the blanks, cutting the teeth, hardening, grinding bores, shanks, etc., and lapping the teeth. The blanks are turned to different dimensions, being larger in the case of the pinion, and of slightly different face and back angle and outside diam-

eter in the case of the gear. Machines for rough-cutting the gear and pinion and for finish-cutting the gear are the same as used for spiral bevel gears and pinions. The pinion finish-cutting machine has additional adjustments for setting purposes, after which the cutting operation itself is the same. The added settings are a vertical adjustment of the work-spindle in accordance with the offset of the pinion with respect to the gear, and two angular adjustments of the cutter-spindle about horizontal and vertical axes, respectively. These adjustments are clearly seen in the illustration (Fig. 1). In the testing and lapping operations, machines must have the same offset of work-spindles as the pinion and gear shafts are to have in the final assembly.

In cutting pinions, it is found advantageous to cut the top side on one machine and the bottom side on another machine. This saves time, as nearly all the machine settings have to be changed in going from the top to the bottom side. Pinion cutters are then made with all outside or all inside cutting edges, which permits a speeding up of the machine. Cutters of 9 inches mean diameter are used.

Production costs of hypoid gears will vary but little from costs of spiral bevel gears. The cost of the blanks will be changed only in the case of the pinion, where the increase in diameter will call for a slightly larger forging. If advantage is taken of the additional load-carrying capacity and gear diameters are reduced, this will more than offset the additional cost of the pinion blanks. The cutting cost for the pinions will be slightly less, on account of using all inside and all outside blades on the cutters.

The use of a ring gear of smaller diameter, and the location of the rear end of the propeller shaft will have an important influence on chassis design. On account of the capacity of hypoid gears for greater transmitted load, a decrease of about 10 per cent in ring gear diameter can be made without increasing the unit stresses. This makes possible a greater road clearance. The lowered position of the driving pinion removes the chief obstacle to lowered floor boards at the rear ends. Advantage can be taken of this to lower the whole body. A practical point of advantage for any present user of spiral bevel gears, who is considering adopting hypoid gears, is that the change can be made with but slight change in manufacturing method or equipment. As has been already pointed out, the finish-cutting of the pinion is the only major operation requiring machinery different from that used for spiral bevel gears and pinions.

* * *

CUTTING METAL WITH ILLUMINATING GAS

Illuminating gas to replace acetylene, hydrogen, and other fuel gases used in combination with oxygen for metal cutting, has been adopted at the Schenectady plant of the General Electric Co., following a comprehensive study of the economic needs of various classes of work. A special oxy-illuminating gas torch was developed for the purpose, and is now being used for cutting risers in the steel foundry, varying in thickness from 1 to 20 inches. This method is also used on machines in cutting intricate shapes from steel plate. As a result of tests, it was found that illuminating gas is cheaper for machine cutting than either hydrogen or acetylene, while the speed of cutting, after once starting, is approximately equal for all gases. The advantages claimed for the use of illuminating gas are (1) availability; (2) elimination of delays and handling of tanks; (3) low cost; (4) safety; and (5) chemical and physical properties that permit its use in a torch equipped with a superheater, thus effecting marked economies in the amount of oxygen required by the cutting jet.

* * *

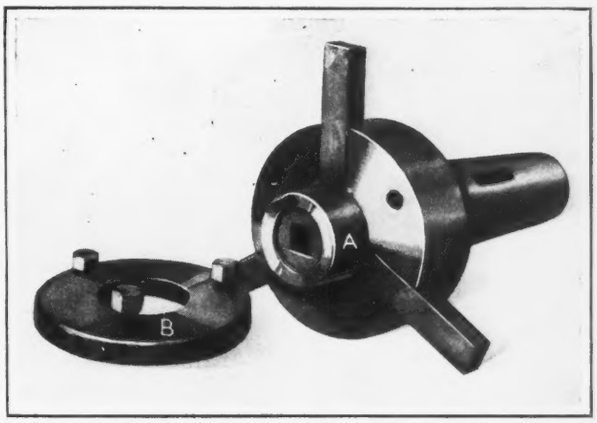
An International Oil Exhibition will be held at the Crystal Palace, London, England, from May 4 to May 21, 1927. The exhibit will deal with the production, refining, transportation, and distribution of petroleum products. Those interested may obtain further information by addressing the International Oil Exhibition, Crystal Palace, London, S.E. 19, England.

ADJUSTABLE BORING HEAD

By F. H. WICKS
Tool-room Foreman, Norfolk & Western Railroad

The adjustable boring head shown in the accompanying illustration can be applied to any horizontal boring machine, or it may be used in the tailstock of a lathe for boring comparatively large holes. The inner ends of the three cutters rest against a tapering surface on plug *A*, and when this plug is screwed into the head, the tools are moved out uniformly. In this way, variations in diameter are obtained. The plug has micrometer graduations to indicate the changes in diameter; thus, a one-eighth turn of the plug expands the cutters 1/64 inch, whereas a complete turn expands them 1/8 inch. Clamp *B*, which fits over plug *A* and is held in position by the three bolts shown, has been removed to show more clearly the general construction of this tool.

This cutter-head is not only readily adjusted, but it is also rigid in operation, so that chatter is eliminated. It is now used in preference to a long boring-bar having a single tool which formerly was used for boring air pump cylinders, deck castings, and other cylindrical surfaces ranging from 8 to 20 inches in diameter. In spite of various devices for holding the boring-bar rigid, there was more or less bending, which



Adjustable Boring Head for Use in Horizontal Boring Machine or Lathe

resulted in variations in the diameter of the hole bored. This new boring head has a decided advantage over the boring-bar method, because of the time saved and the greater degree of accuracy obtained.

* * *

SELECTING GLUE FOR PATTERNMAKING

Patternmakers have often found that glues act as an abrasive and that tools dull rather quickly when they are used for machining glued wood. Some glues are harder than others, and if the glue line of a joint made with a very hard glue is allowed to pass its entire length several times over the same spot in a planer knife, a nick is very likely to develop that is expensive to remove. In many cases, therefore, it would pay a manufacturer to use the glue which is the least abrasive of those having the qualities desired.

The Forest Products Laboratory of Madison, Wis., suggests the following test to determine the comparative hardness of joints made with different glues: A number of pieces of wood (preferably soft woods) are glued together face to face, each individual joint being produced with one of the glues to be tested. After the laminated block has been allowed to condition for a week or more, one edge is cleaned of excess glue and squared up. The block is then run repeatedly over a jointer in such a way that each glue line passes over only one spot in the cutter. The depths of the nicks caused by the hard glue lines are then a rough measure of the abrasive effect of the glues. It is difficult, however, to detect differences in the nicks by visual inspection. A better way is to run a smoothly planed soft wood board across the dull knives. The lines on the board will indicate which glued joint produced the deepest nick in the cutter.

Screw Machine Cost Estimating*

Items Upon Which Costs of Automatic Screw Machine Products are Based, and Use of Cost Estimating Data Sheets

By J. M. HEMPHILL, Davis & Hemphill, Elkridge, Md.

ESTIMATING the cost of automatic screw machine products by a "machine hour" rate is considered the most rational method. Such a method has been used successfully in our factory for many years, and it is thought that a brief outline of how the estimate is made, together with certain tables as an aid to the estimator, may be of interest.

The cost of manufacturing an automatic screw machine product is considered as made up of three main items: Net material cost, tool cost, and machine cost. The cost of a pound of material includes the price of the material plus all freight, hauling, storage, and handling cost of both rod and product. The material cost less the scrap value gives the net material cost. Tool cost is usually considered in a lump sum, but in determining it, each tool-room man-hour must carry its proportion of the total tool-room expense, plus a certain amount of the general factory expense.

The machine cost is made up of two parts —setting up, and running. The various sizes and types of machines have different machine-hour rates, established by the cost department on the following basis: The total expense of running a group of machines of the same size and type during a certain period of time divided into the total number of "normal" machine hours for the same group, and during the same period, gives the machine-hour rate for that particular size and type of machine.

The expression "normal machine hours" means total machine hours less time "down" for repairs and necessary delays between jobs, not deducting the time spent on the set-up nor time lost because of any unusual lack of orders for the machines. In our case, these machine-hour rates carry not only their proportion of the general factory expense, but also their proportion of administrative and selling expense. The machine-hour rate used for the set-up should be a greater rate than that for the run. The latter rate includes operators' attendance, but the set-up rate must include the full time attendance of the set-up man. The foregoing outline has been given in order to show clearly the basis for the method used in making the estimate.

The two Data Sheets in this number of MACHINERY give the machine running cost per thousand pieces when the net hourly production and machine-hour rate of the screw machine are known. These two tables will be followed by a third one (in the August number) which is a continuation of the two mentioned, and gives the machine running costs for machine-hour rates varying from $1.25 to $1.75. A fourth Data Sheet in this series (also in the August number) gives the cost per thousand when the total number and total cost are known. These four sheets will be followed by eight others, giving the number of pounds of brass rod (round or hexagonal) needed to make 1000 pieces of a given diameter and length. These tables are used in conjunction with those previously referred to in estimating costs of screw machine products.

The various tables mentioned are made up on a "per thousand" basis, because that makes it possible to readily compare cost items of different pieces, and the estimated cost for any quantity of pieces can be changed easily to estimate the cost of any other quantity.

JAMES MITCHELL HEMPHILL was born in West Chester, Pa., in 1885. He graduated from the Haverford School at Haverford, Pa., in 1902, and from the Rensselaer Polytechnic Institute, Troy, N. Y., with the degree of civil engineer, in 1907. At this institute he remained as instructor in mathematics and surveying for one year. He then studied mining engineering at Lehigh University, and for four years followed that branch of engineering in Cuba, Canada, and the oil fields of Southern California. In 1913 he went to work in the screw machine products factory of his brother-in-law, Marion B. Davis at Elkridge, Md. In 1915 the present partnership of Davis & Hemphill was formed.

Cost Per Thousand, Given Production and Cost Per Hour

By referring to the Data Sheets accompanying this number, it will be noted that the first column gives the number of seconds (stop-watch time) required to make one piece; from this time, the gross production in 10 hours was derived. A deduction ranging from 10 per cent to 30 per cent was then made to arrive at the net production in one hour. Although these deductions may serve somewhat as a guide and may be approximately correct for rather simple pieces, the relation between the gross production based upon the gearing of the machine, or the "gross gearing," and the net production, will vary widely depending largely on how complicated the tooling and how exacting the specifications.

A job that runs on a machine for a month will show a larger net production per hour than a job that runs but a day or so at the same gross gearing. The less the time required to cut up a bar of stock, the greater will be the difference between the gross gearing and the net production. Given the usual attendance of the operator, a machine that requires feeding every five or six minutes will probably show at least a 50 per cent loss from gross to net. The estimator should, therefore, determine for himself the net production he may expect, and use that figure in connection with the tables. These tables can also be used to find the cost per thousand on any secondary operation, if such is required.

Example Illustrating Use of Tables

The small brass piece shown in the accompanying illustration will be used to demonstrate the use of the Data Sheets in estimating the cost per thousand on lots of 1000, 2000, and 5000 pieces, respectively. The following data, which must be known or determined by the estimator, will be assumed.

Cost of brass rod (including handling, etc.), $0.17 1/8 per pound.

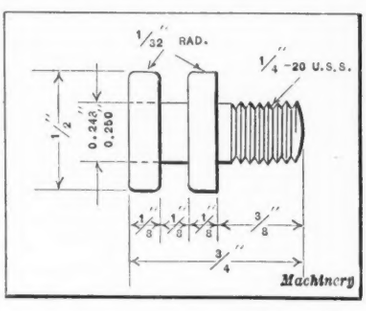
Scrap brass value, $0.09 per pound.

Machine, Brown & Sharpe No. 0—machine-hour rate $0.95.

Net production in one hour, 280 pieces for a lot of 1000, 300 pieces for a lot of 2000, and 340 pieces for a lot of 5000.

Time for setting up machine, 4 hours, and cost, about $6.

Cost of flat forming tool, $2.



Example used to illustrate Method of estimating Costs of Screw Machine Products

*Based upon a paper read before the Screw Machine Products Association—Eastern Division

The piece is 3/4 inch long, but to allow for waste in cutting off, a length of 27/32 inch is assumed in using the table. A table (to be published later) giving the pounds of round brass rod per thousand pieces, shows that for a length of 27/32 inch and a diameter of 1/2 inch, 51 pounds of rod per thousand are required; hence, the cost, at $0.17 1/8 per pound, equals 51 × 0.17 1/8 = $8.75. The estimated weight of scrap is 25 pounds, and its value is 25 × 0.09 = $2.25. Hence, the net cost of material per thousand pieces equals $8.75 — $2.25 = $6.50.

The machine running costs for net productions of 280, 300, and 340 pieces at a machine-hour rate of $0.95 are about $3.40, $3.25, and $2.85 for the 1000, 2000, and 5000 lots, respectively, as shown by the Data Sheet in this number. The various items of cost per thousand for the three lots mentioned are as follows:

	1000 Pieces	2000 Pieces	5000 Pieces
Cost of material per 1000	$6.50	$6.50	$6.50
Machine setting-up cost per 1000	$6.00	$3.00	$1.20
Machine running cost	$3.40	$3.25	$2.85
Tool cost per 1000 pieces	$2.00	$1.00	$0.70
Total cost per 1000 pieces	$17.90	$13.75	$11.25

Allowance for Waste of Stock

The tables to be published later, giving the pounds of brass rod to make 1000 pieces, are based upon a weight of 531 pounds per cubic foot. No allowance has been made in these tables for waste due to facing or cutting off, or to rod ends. The wastage varies so much with different pieces that it is impractical to include it. The estimator must choose from the table such a length as he considers will allow for wastage on the particular piece upon which he is estimating. While a piece of small diameter will require but a thin cut-off tool, compared to that needed on a piece of large diameter, there are times, as when a large hole is drilled clear through a piece, that a thin cut-off tool can be used on a large diameter. Wastage due to rod ends may be high on long pieces. Wastage due to set-ups must be allowed for short runs, particularly when the machining is intricate. The total allowance for wastage should seldom be less than 1/16 inch, and will vary from that to 1/4 inch or even more on rather long pieces of large diameter.

These tables can be used for steel by deducting, roughly, 10 per cent from the weight given, if such correction is deemed necessary. In using the tables for round stock, the weight of square, hexagonal, or octagonal rods can be obtained by multiplying the given weight by the proper constant found at the bottom of each table.

* * *

NEW TYPE OF FRICTION DRIVE

Friction drives are admittedly desirable on account of their silent operation and low cost, other factors being equal. Many drives employing friction rollers for transmitting motion and power from one shaft to another have been produced, and some of these have operated with a moderate degree of success. However, they have generally suffered from a loss in efficiency due to the necessity of transmitting, through the bearings, the pressure required to prevent slipping. According to *The Engineer*, a novel method has been employed to overcome this difficulty in a friction roller drive developed by Garrard Gears, Ltd., 109 Kingsway, London, England.

The principle of the drive can best be explained by reference to the accompanying diagrammatic outline of the essential parts. At *A* is the driving wheel and at *B* the wheel to be driven. *C* is an idler and *D* a ring embracing the whole assembly. The wheels, or rollers, are of hardened steel, ground with a very high degree of accuracy, and the ring, which is also hardened, is stretched very slightly to get it in place. The result is that all the rollers are held firmly together but not so tightly that any appreciable amount of torque could be transmitted from one to another in this condition. Considerably more force must be used in pressing the rollers together in order to make the drive practicable, and this force is provided automatically, within the mechanism shown, in the following manner.

It may be assumed that the driven shaft *B* is held stationary. Then the idler *C* will also be fixed, and the point *E*, where *C* and *D* make contact, will form an anchorage. Now, as *A*, the driver, is rotated, there will be a tendency for it to slip on *B*, and as there is no very great pressure between the two, the point *F* will rise if the gear is running in the direction indicated by the arrow. The result will be that the ring will rise, rotating about *E*, and the rollers will be gripped across a narrower part of the ring than the diameter. The grip is, in fact, limited only by the coefficient of friction and the strength of the ring. It will be noticed that not only is the gripping force between the rollers wholly counterbalanced by the tension in the ring, so that no extra load is put on the bearings, but also that two driving contacts are made, one directly between *A* and *B* and the other from *A* to *D* through *C* and back to *B*. The result is, of course, that the rollers can be of half the length that would be necessary if *A* and *B* were pressed together by some external force. It is hardly necessary to point out that any of the three rollers can be used as the driver or driven member.

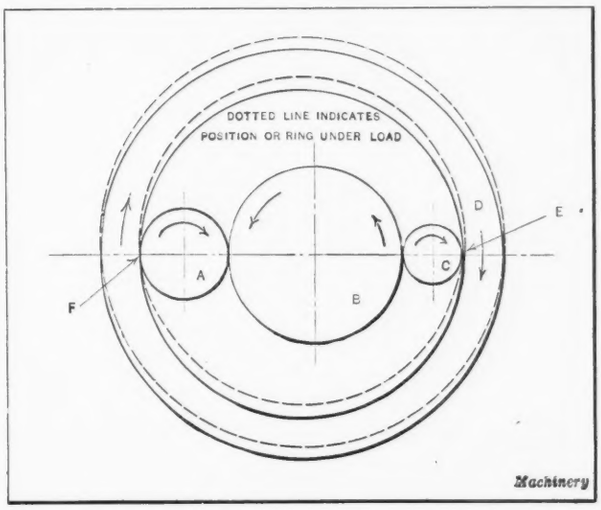


Diagram illustrating Principle of New Type of Friction Drive

As regards wearing qualities of this drive, several sets are said to have shown that no appreciable wear takes place, largely on account of the comparatively light load imposed on the rolls and bearings. When it is necessary to transmit considerable power, several separate rings are used instead of one wide one.

Although the authors of the original article are not able to give independent detailed figures as to the mechanical efficiency of the new type of drive, there is every reason to assume that it is high, and the makers claim that with the plain cylindrical rollers, an efficiency of 98 per cent is obtained at all loads, and some tests showed that the heat generated inside a 25-horsepower drive at full load, which, of course, represented the internal losses, could be supplied electrically at an expenditure of 200 watts. They will carry heavy overloads, and the authors say that they failed to make a set slip even with the assistance of a long pinch bar. Incidentally, the rollers were not marked in the least by this severe treatment. A turbine gear for transmitting 1000 horsepower at 6000 revolutions per minute is now being made in the Midlands, and it is hoped to subject it to exhaustive tests shortly.

* * *

The principal machinery imports into Venezuela consist of oil-well drilling equipment and other oil-well machinery, power plant equipment, mining and pumping machinery, and textile, sewing, and shoe machinery. The exports of oil-well equipment from the United States to Venezuela were valued at $2,288,000 in 1925.

FINDING WEIGHT OF STOCK FOR A GIVEN NUMBER OF PIECES

By A. J. PRUSZYNSKI

The writer has frequently been called on to calculate the weight of stock required to make a given number of pieces from such materials as flat strip stock, round bars, or tubing. As the tables of weights of stock available did not contain the information required in such cases, the simple formulas here given were worked out by the writer. These formulas give the weight of flat or round stock, or tubing of any size.

Let

M = weight of flat strip stock required for 1000 pieces;
N = weight of round bar stock required for 1000 pieces;
O = weight of round tube stock required for 1000 pieces;
A = width of flat strip stock;
T = thickness of flat stock;
B = spacing of blanks in strip, single row;
C = number of rows of blanks in strip;
D = outside diameter of tubing or solid bar;
d = inside diameter of tubing;
L = length of stock (round bar or tubing) required for one piece, plus the width of the saw cut;
W = weight of cubic inch of given stock; and
P = percentage allowance for losses.

Then the general formulas for M, N, and O, are as follows:

$$M = 1000 \frac{A}{C} \times B \times T \times W \times \left(1 + \frac{P}{100}\right) \quad (1)$$

$$N = 785.4 \times D^2 \times L \times W \times \left(1 + \frac{P}{100}\right) \quad (2)$$

$$O = 785.4 \times (D + d) \times (D - d) \times L \times W \times \left(1 + \frac{P}{100}\right) \quad (3)$$

If we assume that P equals 5, which is the generally accepted percentage allowance for losses, then we have

$$M = 1050 \frac{A}{C} \times B \times T \times W \quad (4)$$

$$N = 824.7 \times D^2 \times L \times W \quad (5)$$

$$O = 824.7 \times (D + d) \times (D - d) \times L \times W \quad (6)$$

The writer suggests computing a table of $1050 \times W$ and $824.7 \times W$ for the materials used by any particular concern and using those figures in Formulas (4), (5), and (6). This substitution will make the calculation easier by reducing the number of factors in each formula by one.

Let $1050 \times W = E$ and $824.7 \times W = F$. Then the final formulas for M, N, and O are as follows:

$$M = \frac{A}{C} \times B \times T \times E \quad (7)$$

$$N = D^2 \times L \times F \quad (8)$$

$$O = (D + d) \times (D - d) \times L \times F \quad (9)$$

With the preceding formulas, the weights of stock required for any given number of pieces are easily found, especially if the calculations are made on the slide-rule.

For a bar with a cross-section which is a regular polygon circumscribed around a circle of diameter D, multiply the results obtained by Formulas (2), (5), and (8) by the proper constant K, given in the accompanying table, which is computed from the following formula:

$$K = \frac{n \times \tan \frac{180}{n}}{3.1416}$$

in which n is the number of sides on the bar stock or tubing.

For tubing with a cross-section that forms similar regular polygons circumscribed around circles of diameters D and d, respectively, multiply the results obtained by Formulas (3), (6), and (9) by the proper constant K, given in the table or calculated by the formula.

For bars and tubing of irregular cross-section, compute the area G of the cross-section and use the following formula:

$$S = 1050 \times W \times G \times L \quad (10)$$

in which S = weight of stock of irregular cross-section required for 1000 pieces.

Substituting E for $1050 \times W$ we have,

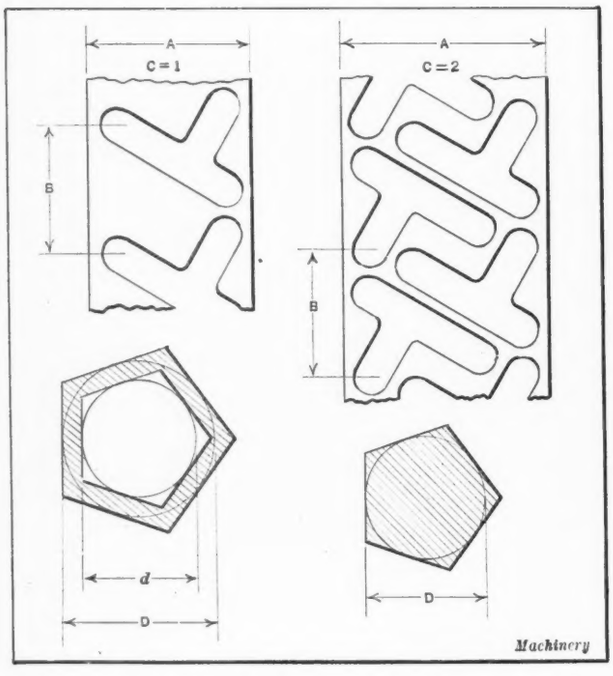
$$S = E \times G \times L \quad (11)$$

TABLE OF CONSTANTS FOR USE IN FINDING AREAS OF TUBING

n	K	n	K	n	K
3	1.654	6	1.103	9	1.043
4	1.273	7	1.073	10	1.034
5	1.156	8	1.055	12	1.023

Machinery

n = number of sides on tubing or bar stock



Diagrams used in calculating Amount of Bar or Tubular Stock required for 1000 Pieces

* * *

LEAD FOIL AND TIN FOIL

Lead foil consists of lead with a very light tin coating, whereas tin foil is made of practically pure tin. The production of lead foil, according to the practice in a plant where large quantities of both lead and tin foil are manufactured, is as follows: Cast ingots of lead about 24 inches square and 1 inch thick are passed through the first breakdown mill, thus reducing the ingot thickness to about 1/2 inch and increasing the length to about 42 inches. A casing or covering of pure tin, about 1/64 inch thick, is next placed on the top and bottom of the ingot. The latter is then passed through the next breakdown mill. Two more passes, or four in all, reduce the ingot to a thickness of about 1/16 inch and increase the length to approximately 40 feet. Usually only one pass is required in the finishing mill, thus completing the operations in producing lead foil. This lead foil, common foil or "four per cent," as it is sometimes called, contains about 4 per cent tin and 96 per cent lead.

Tin foil, which is made from cast ingots of tin, is produced by the same general process, although tin foil is given eight passes through the finishing mill, and the ingot is not, of course, covered with a separate layer of tin as in making lead foil. The latter is usually mounted on wax paper, but when food products are packed with foil alone, pure tin foil must be used.

Making Automobile Fenders with Hand Tools

Methods Employed in Making a Set of Fenders for the First Car of a New Model

By EDWARD HELLER

THE problem of making a set of automobile fenders without special tools is quite an interesting one, and is one that is encountered every time a new car is designed. Every style or model of car that is now seen on the road was at one time in the experimental stage, when every part had to be made by hand or on standard machines without special tools. While one automobile engine can be built without much trouble in any well equipped machine shop, it is not so easy to make a full-crowned fender without dies. This work has to be done, however, and is accomplished in the manner described in the following. When an order for a set of experimental fenders is given to the sheet metal manufacturer, the job starts, as it should, on the drawing board.

Lay-outs for New Fenders

The outlines of a typical fender are shown in Fig. 4. The front fender is shown at *A*, the rear fender at *B*, and the general section of the crown and the apron at *C* and *H*, respectively. First, an accurate, full-size lay-out is made by the draftsman. The front fender is the one that presents the greatest difficulty and, therefore, is dealt with first. The lay-out consists of the profile and a number of sections through the crown. It will be noted that the lines *D* and *E* determine the shape of the sections. It requires considerable foresight, however, to lay out the sections so that they will blend into one another, and produce the desired appearance.

In the case of the front fenders, the crowns are not alike. This is due to the fact that the apron *H* meets the crown at a slope, and thus necessitates making the crowns right- and left-hand. The side of the crown that is joined to the apron must have the same slope as the latter member, in order that the lines of the finished fender will blend harmoniously. The outside flange *I* of the crown is usually vertical. The slope of the apron makes it necessary to develop a seam line where the crown and apron meet. This line is seen as a straight line in the plan and end elevations, but takes a definite form in the side elevation. It is with the aid of this line that the apron itself is later developed. This, however, is a little aside from the problem we are now dealing with, as such methods are used in fender developing in general and are not a part of the problem of making fenders by hand.

Making the Wood Forming Blocks

The full-size lay-outs are given to the woodworker, who proceeds to build and shape the forming blocks. In Fig. 5 the forming block is shown at *A*, and the clamp block for the front crown at *B*. The form for the rear fender is shown in Fig. 1. The forming blocks are built up from sections fastened together with screws and glue. The upper face, where the hammering is done, is built up from maple wood, while the remainder of the structure, including the upper clamping block is built up from white pine. In addition to the forming blocks, skeleton forms, as shown in Fig. 7, are made for forming the aprons for the front fenders. These are made up of sections that have the proper contour for different stations of the apron. Two forms of this kind are necessary—one for the right- and one for the left-hand apron.

Preparing the Fender Blank for Forming

Experimental fenders of the type shown are, as a rule, made of aluminum of a gage equivalent to a thickness of about 1/16 inch. A tape line is stretched over the center of the form and across the deepest section. These measurements, together with the proper allowance for trimming and extra material for rolling in a wire in the outer flange, determine the size of the sheet-metal blank to be used. The sheets are cut, trimmed, and notched, as shown at *J*, Fig. 4. The dimension *K* is made equal to the width of the fender

Fig. 1. Finishing a Rear Fender Crown

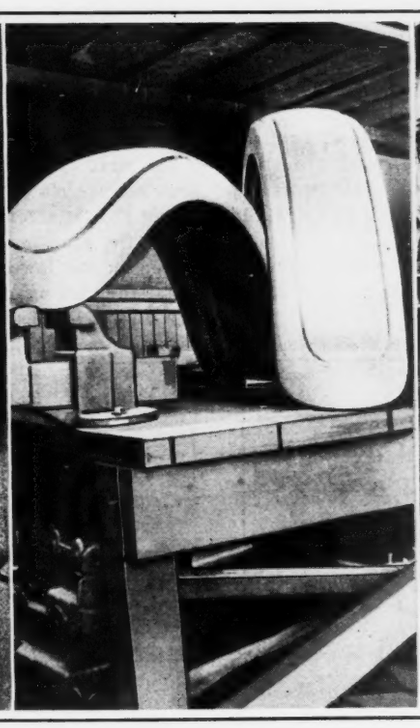


Fig. 2. Finished Crowns for Front Fenders

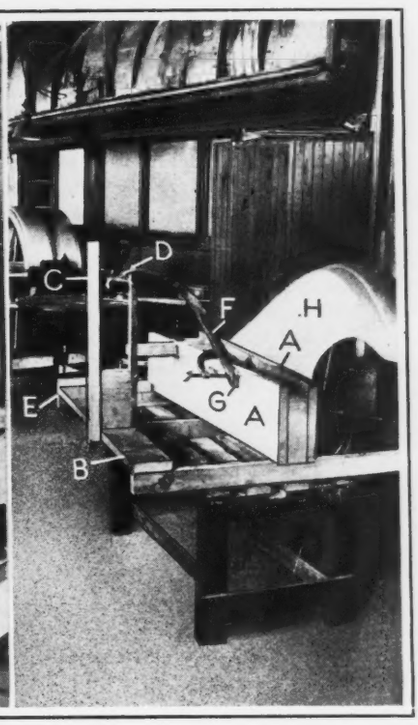


Fig. 3. Fitting and Assembling

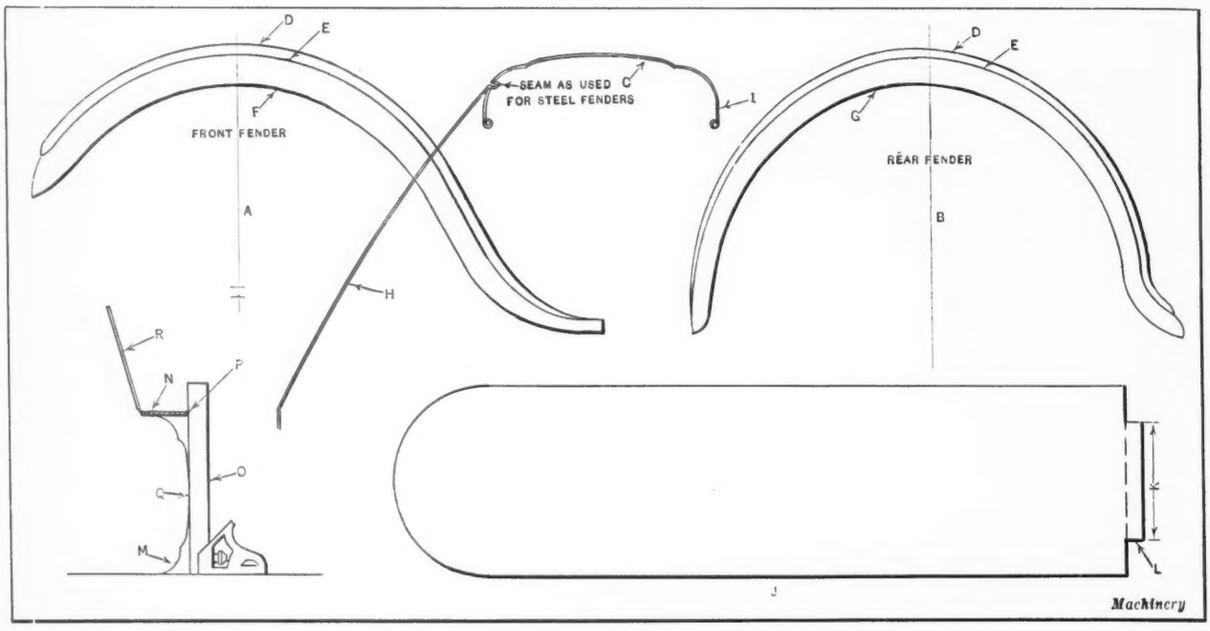


Fig. 4. Outlines of Front and Rear Fenders

less twice the thickness of the metal. The sheets for the rear fenders are left square at this point.

The metal to be formed is first annealed, the annealing being done with a torch. The sheets are heated, a small section at a time, and pieces of newspaper are rubbed over these spots. When the paper begins to char, the aluminum is at its softest stage and is ready for working. The front fender crown blank is shown at *C*, Fig. 5, clamped in place ready for the hammering operation. The sheet is wrapped around the form and held down with seven large C-clamps that are tightened over the wooden clamp block *B*. The tab at *L*, Fig. 4, is bent down over the left-hand corner of the form and secured with long nails. The nail heads are allowed to project about 1/2 to 3/4 inch so that the nails can be pulled out easily when the work is finished.

Hammering or Drawing the Work to Shape

The tool equipment for hammering the crown into shape consists of a small dolly-block, which is held in the left hand, two or three mallets with cross-peens formed on one end of the head, and a steel cross-peen hammer. The same principle is involved in hammering as in drawing the work to shape in a die. In Fig. 6, the workman is shown hammering a crown to shape. The wooden form *A* may be compared to the punch, the dolly-block *D* to the blank-holder, and the mallet or hammer to the die used when the work is formed in a press die. The dolly-block is held under the projecting metal, supporting it on the entire surface of the blank. While the block is held in this position by the left hand, the workman employs the mallet held in his right hand to hammer in the corner and draw the metal over the side of the wooden form.

The unformed flange begins to wrinkle at once, as shown in the illustration, but by working a long section at a time, the wrinkles remain comparatively long and do no harm. In fact, the proper procedure is to go from one end to the other, gradually forming the whole length a little at a time.

At *A* the hammering process is different from that on the upper part of the work. Here the metal must actually be stretched before it can be forced down to form a flange around the wooden form. This is due to the reverse curve in the fender at this point. The bottom of the flange is actually longer than the corresponding line at the top of the crown, and only by stretching the metal, is it possible to compensate for this difference. By the time the metal is flanged down two-thirds of the way, it becomes so hard that a mallet will have but little effect on it. At this stage, it is necessary to use the steel hammer.

As soon as one side of the flange has been forced down where it belongs, it is secured in place, the same as the running board end, and the forming process is repeated on the other flange. This method of making the crown applies in every respect to the rear as well as to the front fenders, and for this reason there will be no need of considering separately the making of the rear crowns.

Trimming the Crowns

The next operation is that of trimming the crowns. Rim templets are made to the outline of the crowns on the lines *D* and *F*, Fig. 4, for the front fenders and on the lines *D* and *G* for the rear fenders. The templets are made 5/16 inch larger on the lower edges *F* and *G*. This allows sufficient metal for curling the edges around a 1/8-inch wire. After the uneven edges of the crowns are rough-trimmed, the

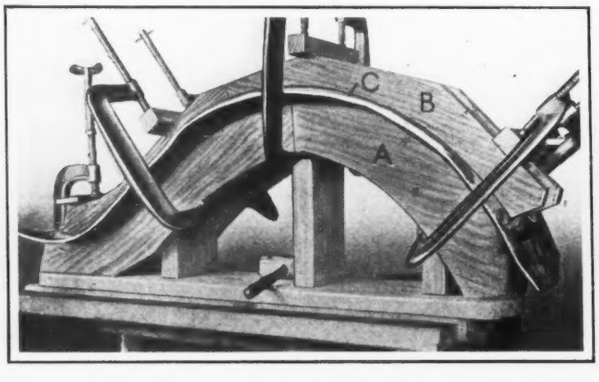


Fig. 5. Crown Blank clamped to Forming Block

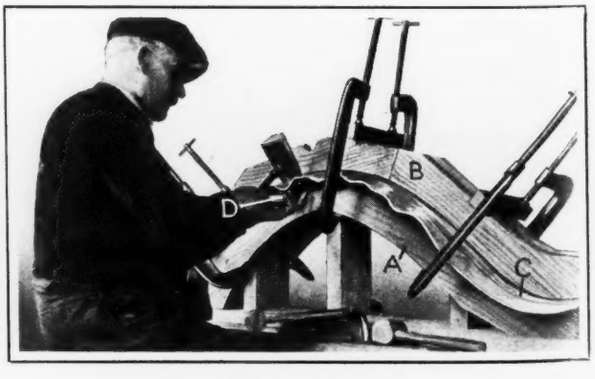


Fig. 6. Hammering Fender Crown to Shape

crowns are laid on their sides on a surface plate and the templet lined up on the upper side. The method employed for this operation is shown in the view in the lower left-hand corner of Fig. 4.

The crown is shown at *M*, the templet at *N*, and the square at *O*. The square is moved around to different points on the crown until the edge of the templet coincides with the highest point *Q* on the crown. The templet is then fastened to the crown by means of C-clamps, and a line is drawn around the edge of the templet with a scriber *R*. This applies only to the outside edges of the fenders. The edges of the fender that are nearest the center of the car must have an entirely different treatment. In making the rear fenders, a considerable portion of the crown must be cut away to clear the wheel house of the body, while in the case of the front fenders, the inner edge must be trimmed to match the apron, as previously mentioned. At any rate, as much of the edge as can be wired is trimmed to conform with the templet, and rolled over the wire.

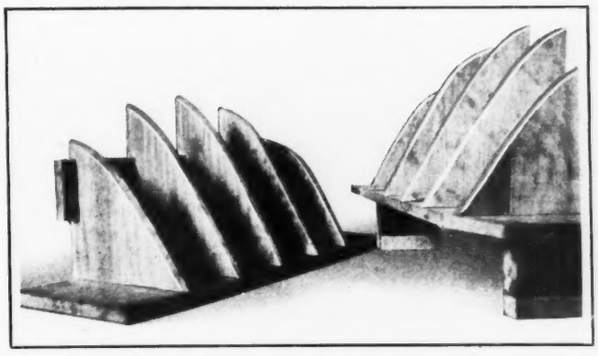


Fig. 7. Skeleton Forms used in shaping Aprons

Smoothing and Polishing the Formed Work

The finishing operation on the crowns consists of "bumping" out all hammer marks and then filing the entire surface smooth with a "Vixen" file, after which it is polished with emery cloth and oil until it presents a smooth and uniform surface. This is quite important, as the slightest buckle or wave shows up very clearly when the fenders are finished with high gloss enamel.

A great many difficulties are encountered in the finishing operation, one being that the whole fender is rather flimsy and it is difficult to hold the crown securely enough to permit filing it. In Fig. 1, is shown one method of filing. The crown is forced back on the forming block, and the light aluminum is thus well supported. This illustration shows the rear fender undergoing the filing operation. In Fig. 8, is shown a method of holding the front crown while filing the reverse curve. A block of wood *A* is nailed to the bench, and the crown is fastened to the block by means of the C-clamp *B*, while the two edges rest against the bench. In the illustrations Figs. 2 and 9, are shown a pair of front and rear crowns, respectively, after they have been filed and polished.

The developing of the blank for the apron is a problem in descriptive geometry, and would be somewhat out of place in this article. However, there are one or two methods of laying out this part that produce an approximate blank that is very close to the requirements. Whichever method is used, an approximate apron blank is cut out and dished by hammering until it lies nicely in place over one of the skeleton forms shown in Fig. 7.

Fitting and Assembling the Crown and Apron

In order to obtain the final fit, a fixture such as shown in Fig. 3 is employed, on which both the crown and apron are set up and fitted. In this fixture the sides *A* represent the frame of the car, both with respect to the height above the running board and the slant from the center line of the car. The extreme width of the fixture measured from the outer edges of the pieces *B* represents the extreme width of the car as measured from the outside edges of the fenders. The piece *C* serves as a gage or limit for locating the outer edge of the crown. The height gage upon which the crowns rest is shown at *D*, and a block of wood representing the front end of the running board is shown at *E*.

The apron is clamped up against the fixture while the crown is set up on top of the member *D* and against the pieces *C* and *E*. While the two members are thus held in position, they are marked and trimmed so that their edges will be 1/16 inch apart at the seam line. The whole seam is then welded, making the two members one solid piece. During the welding operation, the two parts are often distorted somewhat, so the resulting unevenness is hammered out, and the welded part filed down and polished. At *H*, Fig. 3, is shown one of the completely welded and finished front fenders.

One of the brackets to which a fender is to be secured is shown at *F*. The brackets are either of the pressed-steel or solid type. With the pressed-steel type, pieces of sheet steel are welded together to form channels of the required shape. If the bracket is to be solid, it is a simple matter to forge it directly to shape. The brackets are fitted to the fenders and to a set of pins at *G*. These pins represent the bolts that are to hold the fender bracket to the frame rail on the car. The brackets are riveted at two or three points to the sheet-metal fenders, thus completing the work. As a rule, there are a number of places on a fender that require reinforcement. In ordinary steel fenders, the reinforcing pieces are welded to the fender, but in the case of aluminum fenders, when the reinforcements are made of steel, they are riveted but wherever aluminum reinforcements are used, they are oxy-acetylene welded to the fender.

* * *

In a paper by J. W. Meadowcroft, presented before the American Welding Society, it was mentioned that in open-type automobile bodies at the present time there are from 1000 to 1100 electric spot welds, from 70 to 80 linear inches of acetylene gas welds, and from 10 to 12 linear inches of metallic arc welds. On an all-steel sedan body, the average amount of welding is still greater.

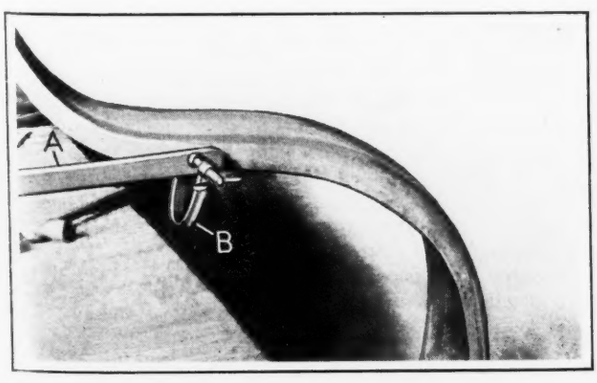


Fig. 8. Method of holding Fender while polishing

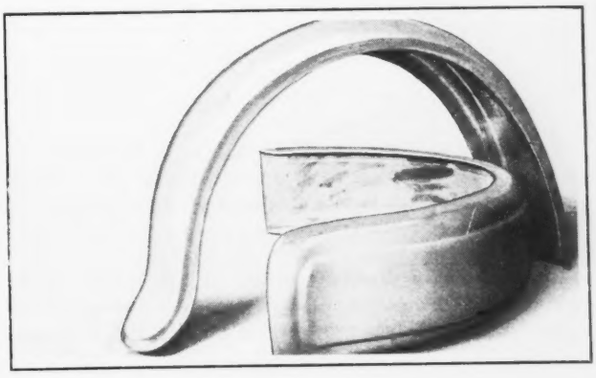


Fig. 9. Pair of Finished Rear Fenders

FOUNDRY COSTS

By JAMES ALLEN THOMAS

There are many foundries, even in this enlightened age of keen competition, where the management treats the entire foundry output, so far as casting costs are concerned, merely on the basis of bulk production. It has been their practice to keep a record of all the material used, and the labor paid for foundry payroll; to the cost of these is added the overhead charge. Over a period of time a certain number of pounds of castings are produced at a certain total cost; this gives the average cost per pound, and to this is added the desired profit to obtain the selling price per pound.

This system of arriving at the cost or selling price of castings entirely neglects the factor of workmanship in producing the different kinds of castings, and the same price per pound is charged for castings with much weight and little labor in molding, as for light castings having a great amount of labor attached to their molding. The case might be presented more forcefully if expressed the other way about: Thus light castings with a great amount of labor attached to their production are sold at the same price per pound as heavy castings that require but little labor in their production. When expressed in this manner, the fallacy of this system and its possibilities as a source of loss are more readily grasped.

In a foundry specializing on a class of work that is about uniform in weight and labor cost per unit, the average cost per pound is a satisfactory basis for determining selling prices. For instance, it is all that would be required in a foundry making nothing but sash-weights. However, if the foundry output is diversified, the average cost would be useless as a guide for pricing something that was different from the foundry average. The plan of using an average cost per pound, has no use or place in any up-to-date method of cost accounting, and should not be used as a basis for setting prices, except in special instances as noted. The results are dangerously misleading, and will not even serve as a guide to determine the relative cost of castings between different periods of time, unless the output is uniform throughout the different periods for which the comparisons are made. If such data are used as a basis for selling prices, they are sure eventually to cause loss of either money or orders.

The results of using such a guide in figuring may, for a time, be productive of profits on the total foundry output, or at least may not cause a financial loss, but sooner or later a job is sure to be handled that will call for a lot of castings that are away outside of the past average. Then if the general average is used as a cost basis, the price will be too high or too low. If the castings offered are heavy, the price will be too high and the job will go to a foundry that knows what its castings cost, and if the price is too low, as would be the case if the castings were below the average in weight, or required above the average amount of workmanship, the job will result in a loss, although it may not show on the books as such because it is buried in the foundry average. If the job were large enough, in the latter case, it could well end in disaster to the proprietor's bank account.

It is never safe to use an average price for anything but average production for the shop for which the average is used. In figuring on castings, in the absence of a proper cost record, it is much safer to consider the job by itself, and estimate the labor that will be required to produce the work, just the same as the weight is estimated when it is desired to give a price per casting.

As an example of this kind of figuring, a certain foundry took a contract for all of certain castings used on light machines that were built in lots of sometimes more than a hundred machines at a time. The manufacturer who gave the contract owned a large foundry and made some of the heaviest machinery castings, as well as light ones, and he knew just what his castings cost individually and in classes. On these light machines were used a great many very light castings, many being from the same pattern. There was not a casting in the lot that weighed more than fifteen pounds, and some of them did not weigh more than a few ounces. The foundry that took the contract for furnishing these light castings did so at a price of two and a half cents per pound, and was glad to get the work at that price. That was about the ruling price for average machinery castings at that time. The manufacturer who gave the contract could not have made the castings for an average price of ten cents per pound and his cost system had told him so. The two and a half cents would not begin to pay for the labor on the castings, to say nothing of the iron, other materials such as sand, tools, flasks, and the overhead.

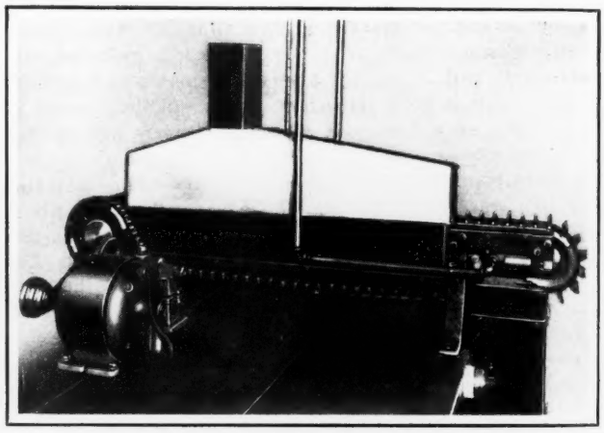
The foundry that gave this job kept a perfect and accurate account of the cost of its individual castings and knew that it was profitable to sublet the work. The foundry that took the work probably kept the average cost of its castings, if it kept any cost at all, and did not know how much it actually cost to produce individual castings or even different classes of castings. There are foundries all over the country today that are selling castings at prices arrived at in this manner. The proprietors are remaining poor, or going broke doing it, and probably cannot understand why this is happening.

* * *

AUTOMATIC SPRING-DRAWING OVEN

By A. D. REDNER, Production Manager
Skinner Automatic Device Co., Inc., Detroit, Mich.

The coil springs used to operate the float mechanism in the Skinner oil rectifier are heat-treated to withstand a temperature of 600 degrees F., when extended, without losing



Automatic Spring-drawing Oven which has a Capacity of 1300 Springs per Hour

their tension. It was found that by bringing these springs up to 600 degrees F. while extended and then cooling them slowly by a light air blast, they would lose 10 to 15 per cent of their original tension. In other words, by winding the springs with 15 per cent additional tension and giving them this heat-treatment, any possibility of their becoming weak in service is eliminated.

In order to take care of this heat-treating operation economically and in production quantities, it was necessary to devise an automatic oven, as shown in the illustration. The oven, which consists of a jacketed tube 26 inches in length, is heated by a gas burner. The temperature is indicated by a thermometer mounted in the center. An operator who sits on the right, hooks the springs on the brackets of a link conveyor. The conveyor speed is set to allow ample time for the heat to be absorbed by each spring in passing through the oven. As the springs are slowly returned under the oven, they are cooled by a series of air jets. Upon again reaching the operator, they are automatically picked off the conveyor and deposited in a container.

This oven has a capacity of 1300 springs per hour and has given excellent results.

* * *

According to a report issued by a large banking house in Sweden, the world's output of ball bearings is approximately 200,000 bearings a day.

Reversals of Circular Motion

A Planetary Gear Mechanism which Provides Reversals Without the Aid of a Shifting Device

By FRANKLIN DeRONDE FURMAN, Professor of Mechanism and Machine Design
Stevens Institute of Technology, Hoboken, N. J.

A PLANETARY gear mechanism using a combination of circular and elliptical wheels may be made to give a unique mechanical movement in which reversal of circular motion takes place without oscillating, reversing, or shifting devices. Continuous rotation of the driver in the same direction gives a continually reversing motion to the follower shaft, which may be made to make a fractional turn or a number of turns in one direction, and then a similar or dissimilar number of turns in the opposite direction.

This unique mechanism was conceived by Dr. Charles W. MacCord, formerly professor of mechanical drawing at Stevens Institute of Technology. A practical application for this mechanism has recently been found, and doubtless other applications could advantageously be made if it were better known. The object is to review this mechanism and to apply the graphical and analytical methods that have been used by the writer in solving planetary gearing problems generally. [An explanation of these methods was published in August, 1924, MACHINERY, page 938, in the first of a series of articles on "Planetary Gearing."—EDITOR]

The mechanism is illustrated in Fig. 1. One of the elliptical gear wheels T_2 is rigidly attached to the frame of the machine, as indicated. The other elliptical wheel T_4 is identical with T_2 and is in mesh with it. The wheel T_4 is keyed to the planetary pin A, and so is the circular gear wheel T_3. The remaining gear wheel T_1 is circular, and in this first illustration is the same size as T_3. The follower shaft O is keyed to the wheel T_1, and it is this shaft that receives the continuous reversing motion already referred to, while the driving shaft N is turned continuously in one direction. The continuous reversing motion of the follower shaft takes place with a variable angular velocity, while the driving shaft has a constant angular velocity. The nature of the angular velocity of the follower shaft may be shown by the graphical method of solution, while the number of turns of the follower shaft forward and backward to one full turn of the driver shaft are shown by the analytical method.

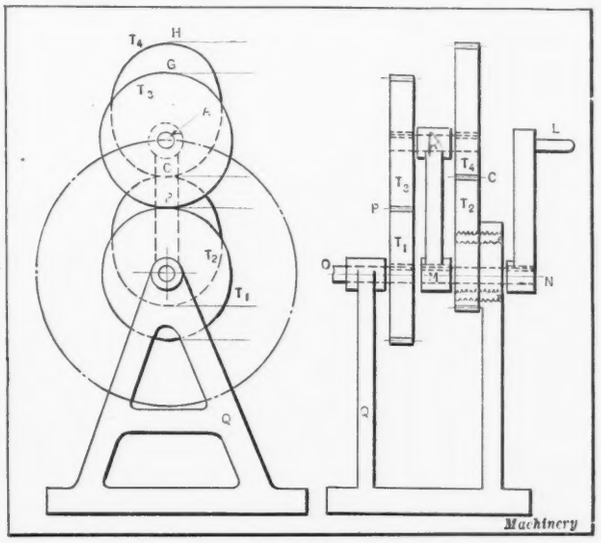


Fig. 1. Planetary Reversing Mechanism using Both Circular and Elliptical Gear Wheels

Graphical Analysis of Reversing Mechanism

The graphical method is illustrated in Fig. 2. Let AB represent the revolutions per minute of the driving train arm MA. Knowing the length of the train arm, the linear velocity of the planet pin A may be calculated; and since this linear velocity may be laid down at A to any scale, AB may also be taken, for convenience, as the linear velocity of the planet pin. AB is also the linear velocity of the point A on the elliptical wheel. Since the point C on the elliptical planet wheel is stationary at the instant shown, because it is in mesh with the fixed elliptical wheel, and since the elliptical and circular planet wheels are rigidly keyed to the same planet pin, the point P on the circular planet wheel will have the linear velocity PE, found by drawing a straight line through B and C. The linear velocity of the point P on the pitch circle of the follower circular wheel T_1 is, therefore, PE. This linear velocity is changed to angular velocity by drawing the line ME and continuing it to F. Then AF is the linear velocity of the point A considered as being on the wheel T_1 extended, or at the unit radius MA, which was the original radius taken to measure the velocity AB of the driving train arm. Therefore the two lines AB and AF are direct measures of the angular velocities of the driving and follower shafts of the mechanism.

Since AB is in a clockwise direction, which direction will be indicated by a plus sign, and AF is in a counter-clockwise direction which will be indicated by a minus sign, the relative angular velocities of the follower and driving shafts at the phase shown will be indicated by the expression $N' = \frac{-AF}{+AB}$. Substituting values for AF and AB, measured to a convenient scale, $N' = \frac{-12}{+6} = -2$.

It will thus be seen that when the circular wheels are the same size and when the elliptical wheels are in the proportion shown, and identical, as rolling elliptical wheels must always be, the follower shaft has a maximum speed of twice the driver shaft and in the opposite direction.

In problems of this kind, the ellipses may be taken in various proportions. In all cases, the major axis CH of the ellipse must be equal to the sum of the radii of the circular wheels, which sum will always be equal to the length AM of the train arm, but the focal length AC may be taken as desired. In the present illustration, AC is taken as one-fourth CH, or what is the same thing, one-fourth of AM. The point A is one focus of the ellipse, and G is the other focus, HG being equal to CA. From this it follows that $CA = HG = GJ = JA$, and that JC is the semi major axis of the ellipse. The ellipse T_2 is identical with T_4. The semi minor axis KC_2 of the ellipse T_2 is found by taking the distance KC_3 for a radius and M for a center, and drawing a short arc which intersects the horizontal line through K. With the proportions here chosen, the angle KMC_2 will be 60 degrees, because $MC_2 = KC_3 = PM$ (the distance between foci) $= PC_2$. Therefore, the triangle PMC_2 is equilateral, and the angle KMC_2 is 60 degrees.

Continuing the graphical analysis, when the train arm AM of the mechanism is turned clockwise 60 degrees, A will be at A_2. At this phase, a velocity diagram will again be constructed by starting with the velocity line A_2B_2 of the driver equal to AB. Completing the diagram, it is found that the points C_2, P_2, and E_2, corresponding to the points C, P and E in the previous velocity construction, coincide at one point.

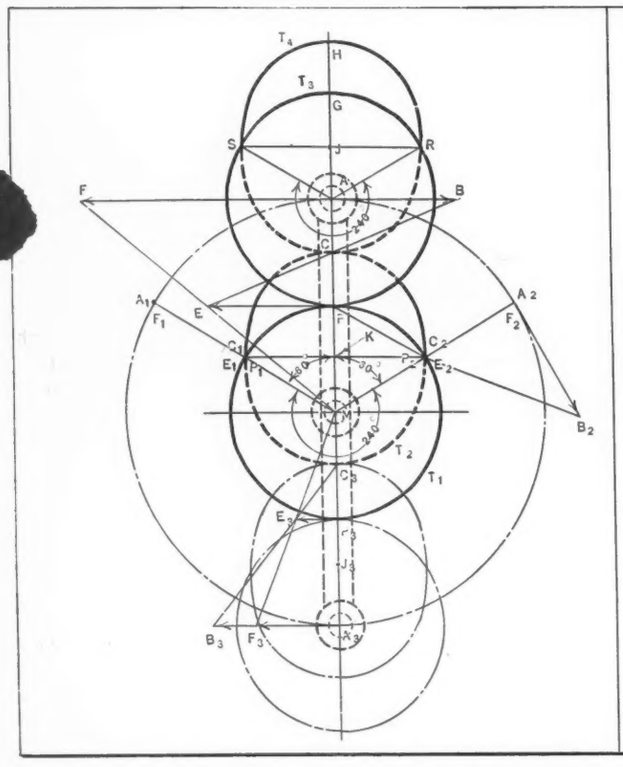


Fig. 2. Graphical Solution for Maximum and Minimum Angular Velocities of the Follower Shaft

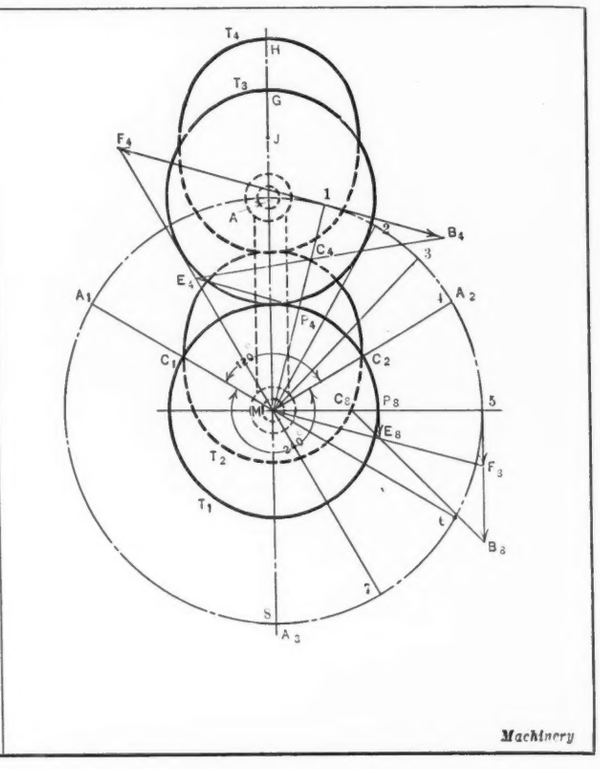


Fig. 3. Graphical Solution for Intermediate Angular Velocities of the Follower Shaft

Also, the line ME, when drawn, coincides with MA_2, and the distance A_2F_2, which measures the angular velocity of the follower shaft, is zero. This means that the follower shaft is standing still at this phase, although the driving shaft is continuing to move at its constant rate. This is expressed by the formula

$$N' = \frac{A_2F_2}{A_2B_2} = \frac{0}{+6} = 0$$

Similarly, the follower shaft is at rest when the train arm is in the position MA_1.

From the preceding paragraphs, it will be seen that while the driving shaft continues to turn clockwise with a constant speed through the upper 120 degrees, the follower shaft will start from rest at the phase A_1; will gain angular velocity until it reaches a maximum of twice that of the follower shaft at phase A; and then lose angular velocity until it again comes to rest at phase A_2. In similar manner, it may be shown that while the driving shaft turns through the lower 240 degrees, the follower shaft starts from rest at phase A_2; gains in angular velocity in the same direction as the driver until it reaches a maximum of two-thirds that of the driver at A_3; and then loses angular velocity until it comes to rest at phase A_1. The value of two-thirds, just used, is found by constructing the velocity diagram at the bottom of Fig. 2, and writing the formula

$$N' = \frac{+A_3F_3}{+A_3B_3} = \frac{4}{6},$$

according to the scale adopted for measuring the lengths A_3F_3 and A_3B_3.

Determining Actual Amount of Follower Shaft Movement

Only the maximum and minimum angular velocities of the follower shaft have been established by the graphical method thus far described. The actual amount of turning of the follower shaft may be determined by plotting a full-cycle velocity diagram, as shown in Figs. 3 and 4. To construct this diagram, lay off a horizontal line of any length, as at A_1A_1 in Fig. 4, and let it represent 360 degrees. It may be convenient in some general cases to make the length of this line equal either to the circumference of the circle AA_3 in Fig. 3, or to one-half the circumference. Divide the line A_1A_1, Fig. 4, into two parts which are to each other as the arc A_1AA_2 in Fig. 3 is to the arc $A_2A_3A_1$. Then subdivide the arc AA_2 in Fig. 3 into as many equal parts as may be desired for making intermediate velocity diagram constructions. Four parts are used in this case. Next, subdivide one-half the line A_1A_2 in Fig. 4 in the same number of equal parts. At point No. 1 in Fig. 3, make a velocity diagram as shown, similar to the velocity construction already described for the point A in Fig. 2. This construction gives an angular velocity of $1F_1$, and this length is laid off at $1F_4$ in Fig. 4 as shown. Similarly, velocity drawings are made at points 2 and 3 in Fig. 3 and laid off in Fig. 4. The curve FF_4A_2 is then drawn in Fig. 4. The curve FA_1 is identical with the curve FA_2, and may be traced in its symmetrical position. In a similar manner, the curve A_2F_3 is laid out, and the curve F_3A_1 symmetrically placed. This complete curve $A_1FA_2F_3A_1$ represents the angular velocity of the follower shaft. Line B_1B_1 represents the angular velocity of the driver shaft.

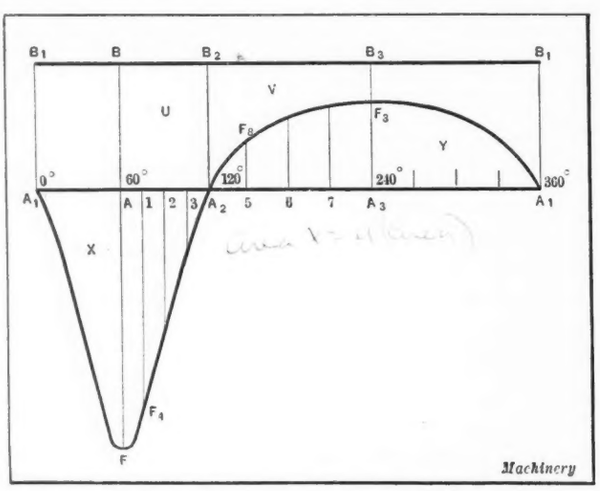


Fig. 4. Angular Velocity Diagram for One Full Cycle of Mechanism represented in Fig. 1

A study of the full-cycle velocity diagram as now obtained in Fig. 4 shows, first, that the maximum ordinate AF is twice the length of AB and on the opposite side of the base line A_1A_1 of the diagram, and therefore that the follower shaft attains a maximum angular velocity of twice that of the driver shaft and in the opposite direction while the driver turns 120

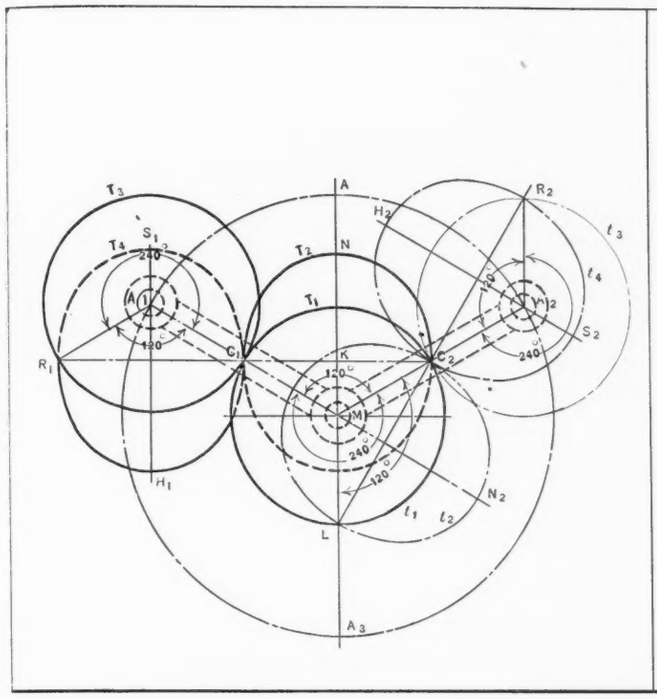


Fig. 5. Diagram for the Analytical Method of Solution

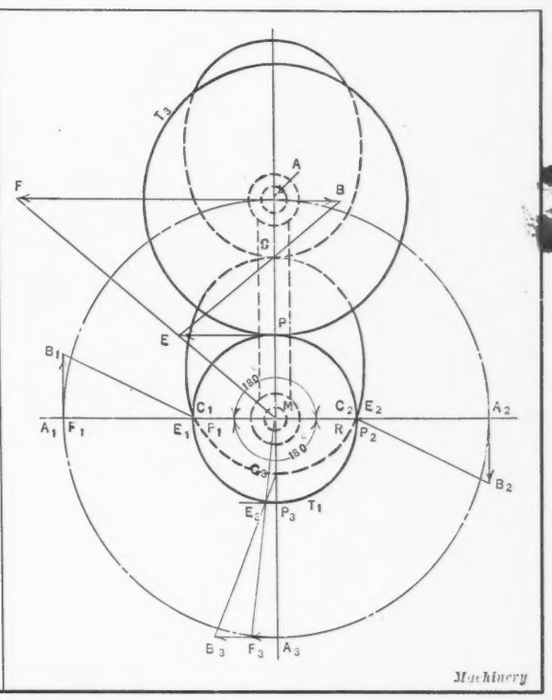


Fig. 6. Effect of changing Relative Sizes of Circular Wheels

degrees; second, that the maximum ordinate A_3F_3 is two-thirds the length of A_3B_3 and on the same side of the base line, and therefore the follower shaft attains a maximum angular velocity of two-thirds that of the driver and in the same direction while the driver turns 240 degrees; third, that the area X included in the curve A_1FA_2 equals the area U included in the rectangle $A_1B_1B_2A_2$, and therefore that the angular motion of the follower shaft is equal to the angular motion of the driver shaft in the opposite direction; fourth that, since the angular motion of the driver shaft is 120 degrees, or one-third turn, the angular motion of the follower shaft is one-third turn also; fifth, that the area Y included under the curve $A_2F_3A_1$ equals one-half the area V of the rectangle $A_2B_2B_1A_1$, and therefore that the total angular motion of the follower shaft is one-half that of the driver shaft, and in the same direction, while the driver shaft is turning through the last two-thirds of its cycle; sixth, that the follower shaft makes one-third turn backward and one-third turn forward while the driver shaft makes one full turn in one direction.

For those not accustomed to thinking of areas in angular velocity diagrams as representing angular motion, it may be pointed out that the abscissa A_1A_1 in Fig. 4, which represents 360 degrees, also represents the time required for the mechanism to go through one cycle of its motion. Since the ordinates AB, etc., of the diagram represent linear velocity at unit distance, and since time multiplied by velocity gives distance, the area of the rectangle $A_1B_1B_1A_1$ must represent the distance traveled by the point A in Fig. 3 during one cycle. Or, in other words, the area just described in Fig. 4 and the circumference of the circle AA_3 in Fig. 3 each represent the distance traveled by the point A during one cycle.

Following this general application, it may be observed that the area U in Fig. 4 represents the arc A_1AA_2 in Fig. 3, and that the area V in Fig. 4 represents the arc $A_2A_2A_1$ in Fig. 3. In the area X, Fig. 4, the velocity ordinates are variable in length, but if their average length is found and multiplied by the length of the time line A_1A_2, the product will give the area X, and this will represent the actual distance traveled by a point that is out a unit distance on the follower shaft. The unit distance in this problem is the length MA of the train arm, Fig. 3.

The analytical method of solving problems in planetary gearing where elliptical gear wheels are used must be ap-

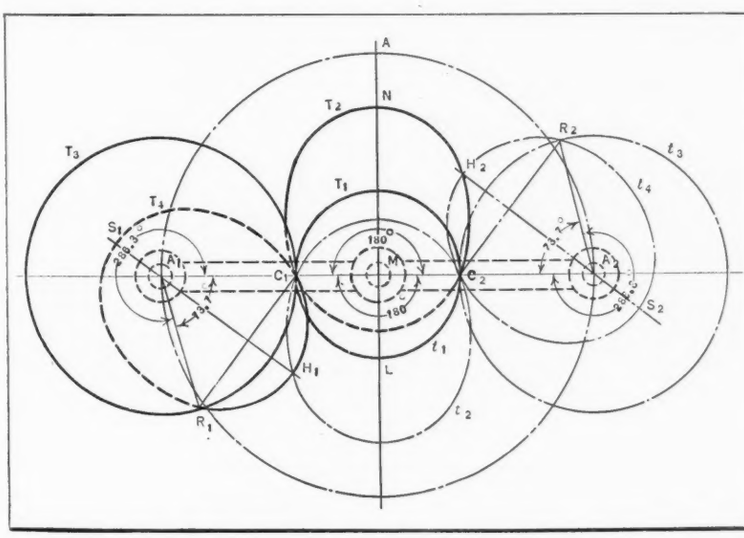


Fig. 7. Diagram for Analytical Method—Circular Wheels of Different Sizes

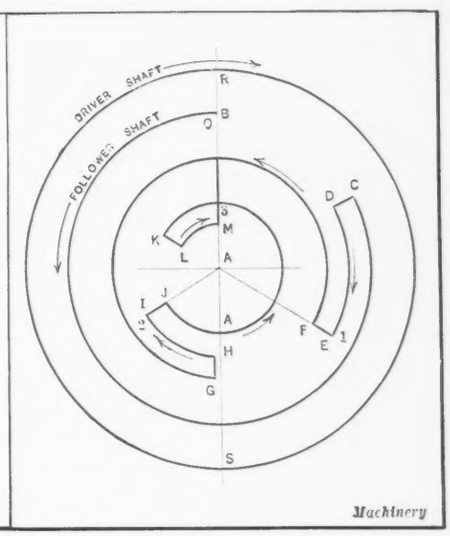


Fig. 8. Relative Motions of Driver and Follower Shafts

plied in two steps (one step for each direction of the follower) instead of in one step, as in problems where only circular wheels are used. Furthermore, the angles subtending the elliptical arcs of action are used with elliptical wheels instead of the numbers of teeth or pitch diameters, as in the case of circular wheels.

Analytical Solution of Reversing Mechanism

In applying the analytical method, the angles through which the driving train arm turns while the follower shaft moves backward and forward must first be determined. These two angles are bounded by radial lines that pass through the points where the pitch circle of the follower wheel cuts the pitch ellipse of the fixed elliptical wheel. The two lines in this problem are MC_1 and MC_2, Fig. 5, and the two angles are the 120 degree angle measured by the arc A_1AA_2 and the 240 degree angle measured by the arc $A_2A_3A_1$.

A sketch should be drawn, showing the pitch outlines of the gears T_1, T_2, T_3, and T_4, and also the driving train arm in the initial position A_1M. Then if all wheels, including the fixed wheel, are locked together and rotated clockwise through the 120-degree angle A_1AA_2, the follower wheel T_1 will have made one-third of a turn while the train arm has made one-third of a turn, both in the same direction. Hence $N' = +1/3$, where N' indicates the turn of the follower wheel per one-third turn of the driving train arm.

The wheels are now in the position shown at t_1, t_2, t_3, and t_4. The elliptical planet wheel t_4, and also the circular planet wheel t_3, which is rigidly connected to it, must now be rotated on the pin A_2 until it has driven the "fixed" planet wheel t_2 back 120 degrees to its original position. The elliptical arc of the "fixed" planet wheel which subtends 120 degrees is shown at LN_2C_2, and the arc of the elliptical planet wheel which must be equal to and symmetrical with LN_2C_2 in order to gear with it, is shown at $C_2S_2R_2$. It will now be noted that this latter arc on wheel t_4 subtends an angle of 240 degrees. Therefore, the planet wheel t_4 and the wheel t_3 must make two-thirds of a turn in order to drive t_2 back one-third of a turn to its original position. Since the circular wheel thus makes two-thirds of a turn, clockwise, the follower wheel t_1 will also have made two-thirds of a turn but in a counter-clockwise direction. This two-thirds turn of the follower is now added, algebraically, to $N' = +1/3$ already obtained, in order to gain the final expression:

$$N' = +1/3 + (-2/3 \times T_3 \div T_1) = -1/3$$

Hence, the follower shaft T_1 makes one-third turn backward while the driver shaft train arm makes one-third turn forward. Since the pitch diameters of the circular wheels are the same, T_3 and T_1 must have the same number of teeth, and the term $T_3 \div T_1$ in the equation will equal unity.

The second step of the analytical solution is similar in analysis to the first step. Briefly, the locked mechanism is turned 240 degrees through the angle $A_2A_3A_1$, Fig. 5. Hence $N'' = +2/3$. Then the planetary elliptical wheel, when turned forward 120 degrees, will turn the "fixed" elliptical wheel back 240 degrees to its starting point. To more clearly understand this last statement, a new sketch should be drawn. This sketch would be a duplicate of Fig. 5, as viewed in a mirror, or from the back of the sheet and interchanging the letters A_1 and A_2. Fig. 5, as it is, may be used for this second step of the analysis if the planet wheel pin A_1 is turned counter-clockwise and if directional signs are allowed for. When the elliptical planetary wheel is given one-third of a turn, the circular planetary wheel is turned the same amount and so is the circular follower wheel T_1, but in the opposite direction. Therefore, this one-third turn is added algebraically, to $N'' = +2/3$ to give the expression

$$N'' = +2/3 + (-1/3 \times T_3 \div T_1) = +1/3$$

The two steps in the analytical solution show that the follower shaft oscillates backward and forward through one-third of a turn while the driver makes one full turn in one direction. The one-third turn backward takes place, however, in one-half the time that the forward one-third turn takes, assuming that the driver turns with uniform angular velocity always in the same direction.

If it is desired that the follower shaft O, Fig. 1, should oscillate through more or less than one-third of a revolution while the driving shaft N makes one complete turn, the result may be obtained by introducing an additional pair of circular gear wheels, one on shaft O and the other on a stud attached to the frame Q. For example, if it were desired to give the ultimate follower shaft on Q two turns forward and two turns backward while the driving shaft makes one full turn, the circular gear wheel at O would have a relative pitch diameter of 6, and the one on a stud attached to frame Q would have a relative pitch diameter of 1.

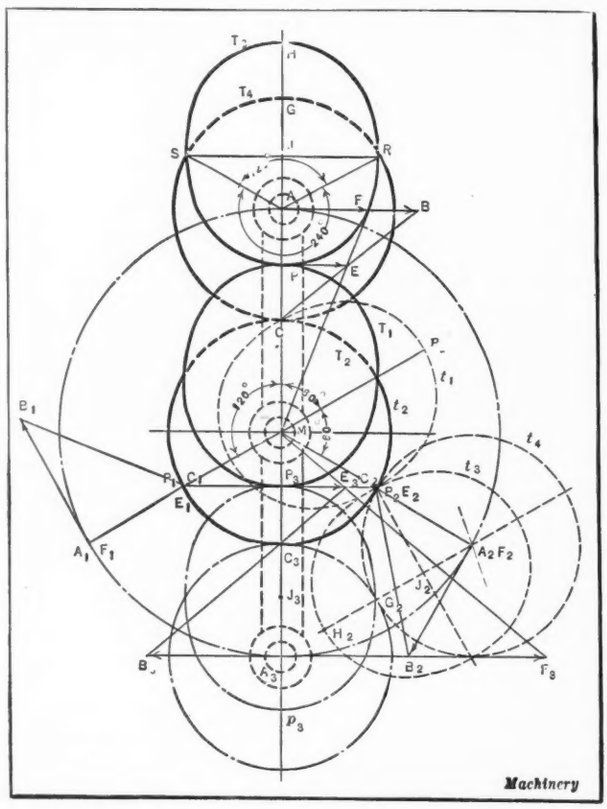


Fig. 9. Showing the Effect of holding the Circular instead of the Elliptical Sun Wheel

Effect of Changing Relative Sizes of Circular Wheels

The general nature of the motion obtained for the follower in the foregoing illustration of planetary gearing in which elliptical wheels are introduced, namely, a certain motion backward and an equal motion forward in different periods of time, may also be obtained by a number of non-planetary mechanisms, such as the well known slow-advance and quick-return mechanisms. It is only necessary, however, to change the sizes of the circular gear wheels in the present planetary mechanism, leaving the elliptical gear wheels the same, to produce a very unusual mechanical motion—one that could not be produced at all with the ordinary slow-advance and quick-return motions, nor with any mechanism that would be comparable in simplicity of mechanical construction with the present planetary device.

The new motion here referred to will be briefly illustrated by changing only the equal circular gear wheels used in the preceding problem, to two circular gear wheels having a ratio of 5 to 3. In Fig. 6, the planet wheel T_3 may be considered as having 40 teeth, and the follower sun wheel T_1, 24 teeth. Considering the graphical method first, it is seen that the maximum velocity backward for the follower shaft is represented by AF when the forward driving velocity is AB. Also the maximum forward velocity of the follower is A_3F_3. It may be noted that the change made in the circular wheels in this problem has doubled the maximum backward velocity of the follower shaft, while the maximum forward velocity has been reduced one-third. The forward and backward rotation of the follower shaft each take place during

the same period of time, namely the time required for the driver shaft M to turn 180 degrees. The actual number of turns of the follower shaft forward and backward may be obtained by the graphical method by constructing a time angular velocity diagram, as was done in the previous problem and illustrated in Fig. 4. This diagram, however, will be omitted in the present problem, and the same answer obtained by the analytical method.

The diagram to be used in connection with the analytical method is shown in Fig. 7. The heavy lines represent the wheels in their initial position in contact at C_1, and the fine lines the final position in contact at C_2. Between these two positions, which are 180 degrees apart, the train arm MA_1 is driving clockwise. Then applying the analytical formula,

$$N' = +1/2 + \left(-\frac{286.3 \times t_3}{360 \times t_1} \right)$$

(The angle 286.3 degrees is indicated on the diagram.)

Since t_3 has 40 teeth and t_1 has 24 teeth, $N' = +0.5 - 1.3254 = -0.8254$, or, the follower shaft makes 0.8254 turn backward while the train arm makes 0.5 turn forward. During the last half turn forward of the driver

$$N'' = +1/2 + \left(-\frac{73.7 \times t_3}{360 \times t_1} \right) = +0.5 - 0.3413 = +0.1587$$

or, the follower shaft makes 0.1587 turn forward while the train arm makes its last half turn forward. These fractional turns of the follower correspond to 297.15 degrees backward and 57.15 degrees forward during each complete turn of the driving shaft. This motion, continued, produces a unique action characteristic of this particular type of mechanism in that the net backward motion of the follower shaft during each cycle is 297.15 degrees — 57.15 degrees = 240 degrees, or two-thirds of a revolution. Stated another way, the follower shaft has a net backward motion of two full turns while the driver shaft is making three full turns forward as illustrated in Fig. 8. The large arc BC measures the angle 297.15 degrees, arc DE, the angle 57.15 degrees, and the angle 241, 240 degrees. The numerals 1, 2, and 3 show the positions of the follower shaft at the ends of the first, second, and third turns of the driver shaft.

Effect of Reversing Positions of Elliptical and Circular Wheels

The effect of changing the elliptical planetary mechanism shown in Fig. 1 by placing the circular wheels in the position occupied by the elliptical wheels, and the elliptical wheels in the position occupied by the circular wheels, with the circular sun wheel T_1 fixed, and the elliptical sun wheel T_2 keyed to the follower shaft O, is illustrated in part in Fig. 9. The latter figure is comparable with the diagram in Fig. 2, where the elliptical sun wheel is fixed. From the two diagrams it may be noted that for the same projected position of the gear wheels, the follower wheel has a maximum clockwise velocity AF of, say, 4 units, in Fig. 9, and a maximum counter-clockwise velocity AF, equal to 12 units in Fig. 2. The forward turning of the follower wheel takes place while the train arm turns through the 240-degree angle A_1AA_2, Fig. 9. The backward turning takes place while the train arm turns through the 120-degree angle $A_2A_3A_1$. The angular velocity diagram for the mechanism as illustrated in Fig. 9 is similar to the diagram in Fig. 4, when viewed from the back, or through a mirror.

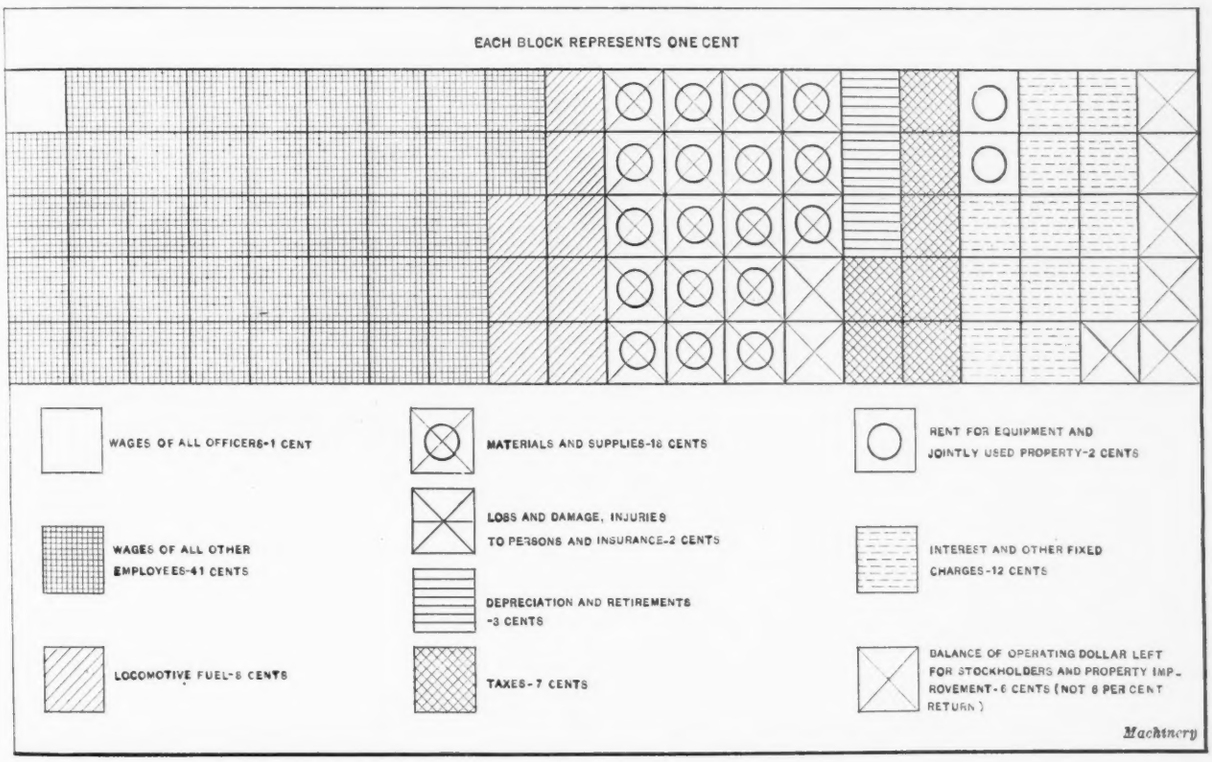
The relative angles turned through by the follower and driving shafts may be readily noted by drawing the wheels as shown by the short dash lines in Fig. 9. It will then be evident that while the train arm turns clockwise through the 120 degree angle AMA_3, the follower elliptical wheel turns 60 degrees in the same direction through the angle PMp_2, and while the train arm turns through the 60-degree angle A_2MA_3, the follower elliptical wheel t_1 turns backward through the 60-degree angle p_2MP. During the complete cycle, the follower shaft turns 120 degrees forward while the train arm turns 240 degrees, and it turns 120 degrees backward while the train arm turns 120 degrees forward.

* * *

Electric locomotives are now being built in sizes unheard of only a few years ago. The Westinghouse Electric & Mfg. Co. has built a number of engines for the Virginian Railway for heavy grade service, two of the engines being capable of taking a 6000-ton train up the heaviest grade on the railroad, while one of them hauls a 9000-ton train on the lighter grades. These locomotives are over 150 feet in length overall, and weigh 642.5 tons.

WHAT THE RAILWAYS DO WITH EACH DOLLAR RECEIVED

(Based on Statistics of the Western Roads)


EACH BLOCK REPRESENTS ONE CENT
WAGES OF ALL OFFICERS-1 CENT
MATERIALS AND SUPPLIES-16 CENTS
RENT FOR EQUIPMENT AND JOINTLY USED PROPERTY-2 CENTS
WAGES OF ALL OTHER EMPLOYEES-41 CENTS
LOSS AND DAMAGE, INJURIES TO PERSONS AND INSURANCE-2 CENTS
INTEREST AND OTHER FIXED CHARGES-12 CENTS
DEPRECIATION AND RETIREMENTS -3 CENTS
LOCOMOTIVE FUEL-6 CENTS
TAXES-7 CENTS
BALANCE OF OPERATING DOLLAR LEFT FOR STOCKHOLDERS AND PROPERTY IMPROVEMENT-6 CENTS (NOT 6 PER CENT RETURN)
Machinery

BEARING PEDESTAL OF NEW DESIGN

By HERBERT A. FREEMAN

The bearing pedestal shown in Fig. 1 has no cylindrical surfaces that require machining. All finished surfaces are flat and without shoulders. A separate unit supports the journal box, and the pedestal cap is a light-weight casting, the only function of which is to exclude dirt from the bearing. Although the bearing was designed because of the necessity for finishing the part on machine tool equipment that was too small to handle the work called for in the usual design, many unexpected points of merit were developed.

Except for the much smaller cap bolts, the pedestal does not differ materially in appearance from the conventional design. The apertures in the ends of the head castings through which the shaft projects are left rough, enclosing washers of sheet metal, which encircle the shaft, being used to give a finished appearance.

At *A* is the journal box support, which is shown in the detailed view, Fig. 2. This support rests, as shown, on a flat bearing surface in the pedestal. With the journal box bearing surface or seat made as a separate part, the making of the pattern and core-boxes is greatly simplified. In fact, it is feasible to make the mold without any separate cores, using a three-part flask, the small amount of hanging sand being supported by gaggers.

The oil cellar is simply a basin-like cavity, which can be readily inspected and thoroughly cleaned so that no sand from the mold will be permitted to find its way into the bearing. Many bearings that mysteriously run hot after months of satisfactory service do so because the lubricating oil, in time, dissolves the burned sand that adheres to the inaccessible cavities of the conventional type of integral bearing support. This grit finds its way into the bearing and causes trouble.

The bearing support *A* is a casting of either iron or steel. It is small enough to be machined on a medium sized lathe. The groove in the spherical seat, shown in the enlarged section *Y–Y*, Fig. 2, is "cast in." It provides an oil duct, in case pressure lubrication is employed, and also serves as a gaging device, when machining the spherical surface.

With a single-point tool held in a spherical boring-bar, it is necessary, under ordinary conditions, to complete the entire spherical cut before the work can be gaged. The groove obviates this, as the tool can be rotated in the boring-bar until it cuts the maximum diameter, which will be the diameter of the spherical surface. With the point of the cutting tool in the groove, as shown at *B*, Fig. 2, a short cut is taken, bringing the tool point to the position shown at *C*. The short cylindrical surface thus machined, can be readily gaged, after which the spherical feed mechanism can be engaged and the surface finished to size. The point of the tool must, of course, be ground so that it will cut when fed in either direction.

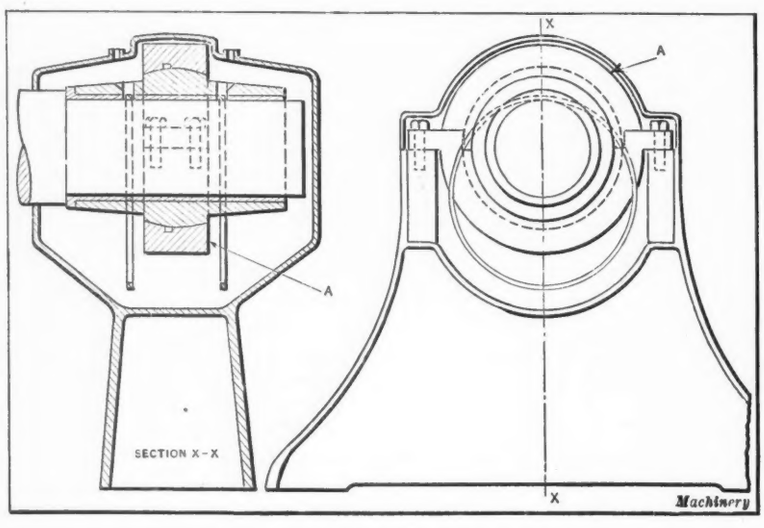


Fig. 1. Bearing Pedestal of New Design

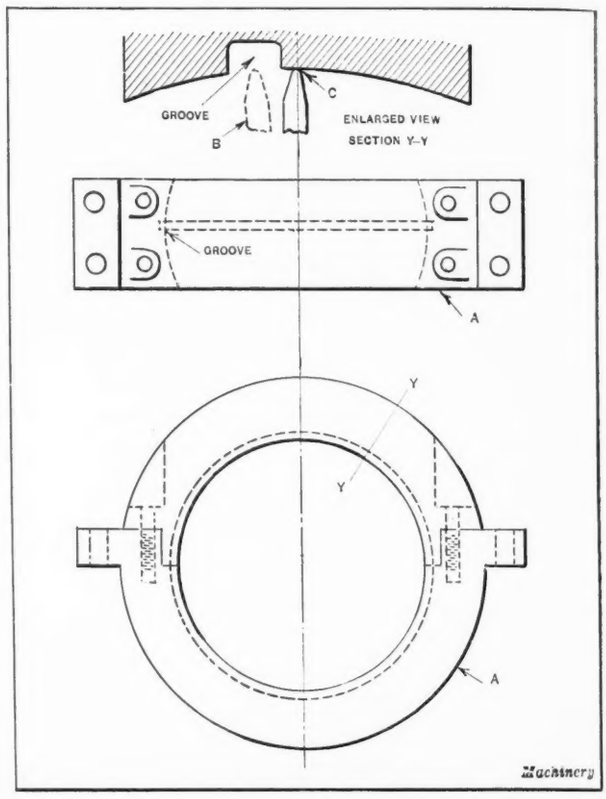


Fig. 2. Journal Box Support

This type of pedestal can be lined up in approximately the correct position, and permanently held in place, after which exact alignment is obtained by inserting liners between the pedestal and the journal box support. Electrical machinery frequently requires insulation between the bed-plate and the pedestal in order to interrupt electric currents which would otherwise circulate through the shaft and bearings, causing heating of the journals. This insulation is often compressible to a considerable degree under sustained loads, and gradually collapses enough to throw the shaft out of alignment. It is then necessary to shim up the low pedestal—a process that, in the case of the usual type of pedestal, necessitates disturbing the insulation, and consequently involves the risk of permitting electric current to pass through the shaft bearing. In the design shown in Fig. 1, the liners are entirely separated from the insulation, which needs never be disturbed in realigning the bearing.

The open spaces between the bearing support and the pedestal cap are an advantage in the case of high-speed shafts. It is necessary, in the usual design, to provide various ducts and cored holes in the pedestal cap in order to equalize air pressures in the different parts of the bearing chamber; otherwise, oil-throwing and false oil-levels will obtain. These refinements are unnecessary in the present design. The same pedestal can be used for both rigid and self-aligning bearings of different diameters.

* * *

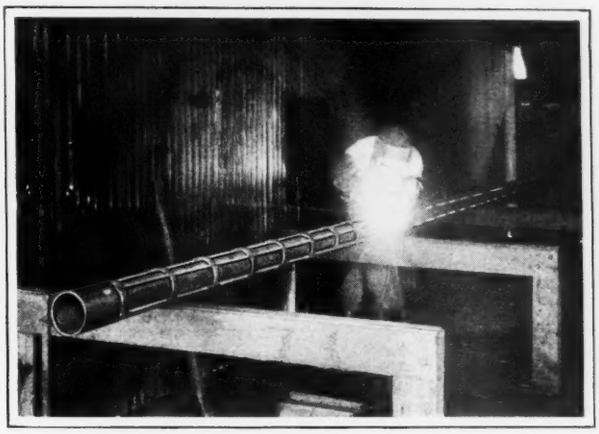
A plan to provide adequate employment statistics so that the actual state of the earning and, consequently, the buying power of the industrial population of the United States, and the employment conditions in different industries, may be properly judged, is proposed in a report to prevent periods of extensive unemployment, recently issued by the Russell Sage Foundation, 130 E. 22nd St., New York City. The plan presents a study made under the direction of a committee of the American Statistical Association.

Notes and Comment on Engineering Topics

In Kings River Canyon, about fifty miles from Fresno, Cal., work has been started on drilling a tunnel 19,400 feet long through solid rock for the diversion of water from Kings River, thereby creating a waterfall 2470 feet in height. This project, which will provide the highest head of water of any power plant in America, is expected to develop 40,000 horsepower immediately, with possible expansion until it eventually will produce 500,000 horsepower.

The remarkable growth in size and capacity of steam turbines is without precedent. Twenty years ago a 1000 K. W. turbine, and ten years ago a 30,000 K. W. turbine were considered remarkable. Last year a 60,000 K. W. turbine was considered the practical limit, but today there is actually an 80,000 K. W. cross-compound turbine nearing completion in the plant of one of the large electrical manufacturing companies.

Through the application of electric arc welding, means have been found for greatly strengthening screen pipe used in connection with the drilling of oil wells, so it is now likely that it will be possible to open up oil deposits that have formerly been too deep to be reached on a profitable basis. In the past, screen pipe used for oil well drilling frequently collapsed under pressure when used in very deep wells, especially when a depth of from 5000 to 7000 feet was reached. A new type of screen pipe which, it is believed, will successfully overcome the difficulties met with, has been developed by E. M. Smith Co. of Los Angeles, Cal. By using Lincoln electric welding equipment, longitudinal reinforcement bars are fastened to the pipe, and between these bars are placed reinforcing segments or crosspieces bent to fit the pipe.



Oil-well Screen Pipe being reinforced by Electric Arc Welding

Engineering advances in railway motive power and equipment are directly responsible for the noteworthy results that are being obtained in railroad operation. One of the significant changes that have occurred in the last few years is the extension of locomotive runs from single divisions of 100 to 150 miles to two or more divisions. On some railroads locomotives are regularly making runs of over 500 miles without being detached from the train. A locomotive recently made the run from Harmon, 30 miles north of New York, to Chicago and return with no other attention than supplying it with fuel, water, and oil.

On the basis of the experience of the Detroit Motor Bus Co., which has operated a fleet of six-wheeled motor coaches for a considerable length of time, it is believed that the six-wheeled type of bus construction has before it a very important future, not only for passenger transportation, but for the heavier type of trucks, enabling heavy loads to be handled safely with greater speeds and with less damage to the roads. Among the important features mentioned in favor of the six-wheeled vehicle are the lower maintenance cost, as compared with the four-wheeled type of the same capacity, and greater safety, because these six-wheeled buses are not so likely to skid.

Compression tests of concrete are generally made on cylindrical specimens 6 inches in diameter and 12 inches long. This form is not always convenient, as, for instance, when the specimens have to be cut out from actual structures. It has long been known, on the other hand, that the resulting test figures vary somewhat with the size and form of the specimen. An investigation of the influence of these two factors, and of a number of the conditions under which the concrete has been made, has recently been conducted at the Structural Materials Research Laboratory of the Lewis Institute, Chicago, Ill., and is described by Harrison F. Gonnerman in Bulletin No. 16 of this laboratory.

NEW LIGHT-WEIGHT ELECTRIC DRIVE

A new drive for automobiles and motor coaches that dispenses with all change speed gearing and the necessity for gear shifting, and that gives smooth operation and rapid acceleration, has been produced as a result of ten years of research and development work. It is an electrical drive, but is claimed to overcome the two great disadvantages of this type of drive—excessive weight and cost. E. M. Frazer, consulting engineer, of Yonkers, N. Y., described it at a meeting of the Cleveland section of the Society of Automotive Engineers recently. The new Frazer electro-control unit is a single unit that performs all of the functions of both the generator and the motor, not only acting as a variable-speed transmission, but also replacing the lighting generator, starting motor, flywheel, clutch, and foot brake, as well as the gear transmission. It thus eliminates the weight and cost of these parts. Moreover, it permits the gasoline engine to operate constantly at its most economical speed.

ADJUSTING AIR SUPPLY FOR FURNACES

A new type of centrifugal compressor for supplying air to oil-burning furnaces has recently been installed by the Champion Porcelain Co., Detroit, Mich. This compressor, built by the General Electric Co., delivers 1800 cubic feet of air per minute to the furnaces at a gage pressure of 1 1/2 pounds per square inch, and operates at a speed of 3450 revolutions per minute, directly connected to a 20-horsepower induction motor. One of the features of the installation is that the operator can tell at a glance the volume of air being delivered to the oil furnaces and the corresponding current input, by means of a calibrated scale on the ammeter. This scale is calibrated in amperes and volume (cubic feet of air per minute). The equipment enables the operator to supply any desired volume of air to the furnace simply by adjusting the blast gate, which is a valve in the air line. Regulating the opening of the blast gate will vary the volume of air delivered by the compressor. Thus, all the operator has to do is to adjust the blast gate until the desired volume of air is indicated on the meter.

ROPES FOR POWER TRANSMISSION

Cotton ropes are generally considered better than Manila ropes, because they will transmit more power and will wear longer. The initial cost, however, is greater. Cotton ropes are used chiefly in England, and Manila ropes in the United States. The life of driving ropes depends upon their size and the conditions under which they work. The most economical diameters for cotton ropes range from 1 1/2 to 1 3/4 inches, the larger size being commonly used for transmitting considerable power. Regarding the relative merits of the three- and four-strand ropes, the former is superior in that it will transmit the same power with a fewer number of ropes. The four-strand rope, however, has the advantage of stretching less, and there is a larger surface in contact with the pulley grooves; it is also capable of a stronger splice. A well-made four-strand rope is, moreover, nearly as strong as a three-strand rope, but it requires more skill to splice it. A three-strand rope rotates once for every nine feet of travel; a four-strand rope rotates once for every twelve feet of travel; and a six-strand rope rotates once for every twenty-four feet of travel.

CONTROL SWITCHES

A control switch is used to control the operation of a remote control device, such as a motor or solenoid-operated oil switch, a circuit-breaker, or a rheostat, or a governor motor of a steam engine, water turbine, or other prime mover. It may also be used to close or open circuits, to trip circuit-breakers, oil switches, etc., from some distant point. Control switches are made up in several different forms, such as the plain lever switch type, the drum controller type, and the pull-and-push-button type. They may be single-throw or double-throw, and either single, double, or triple pole, depending upon the service for which they are intended. These switches are usually of small current capacity (under 50 amperes) and are not, in general, called upon to break much current.

MOLDING SAND

Molding sands, which are used in the foundry for the making of molds for castings, are of two classes: (1) "Facing sand," which comes into actual contact with the pattern, and (2) "floor" or "black sand" which is used as a support for the facing sand, and fills up the remainder of the molding box or flask. The floor or black sand is the sand that has already been used as a facing sand. Molding sand is practically a mixture composed of silica and clay, with various proportions of lime, magnesia, iron oxide, organic matter, and water, the essential qualities being porosity, plasticity, and refractoriness. The amount of silica determines, to a large extent, the last of these qualities. The shape and size of the grains of silica and the quality of the clay bond also have an effect upon the heat-resisting qualities of the sand. The less iron, lime, and magnesia the sand contains, the better it is suited for molding purposes, because these substances combined with the silica form the more or less fusible slags called "silicates." The higher the melting point of the metal to be cast, the more refractory should be the sand from which the molds are made. A very refractory sand is required for nickel, which melts at a temperature of 2650 degrees F., and also for steel, which fuses at about the same heat. There are few natural sands that will withstand a temperature of 2500 degrees F. without fusing; therefore, in casting steel, the molds are invariably faced with a very refractory facing of pure silica bonded with fireclay, as ordinary molding sand would produce a pitted surface on the casting.

SILICA

Silica is amorphous silicon dioxide (SiO_2) and constitutes the greatest part of sand and sandy rocks. It occurs naturally as quartz and tridymite, which, when colored, forms some of the gem stones. When prepared artificially, it is a fine, white, tasteless, odorless powder that is soluble only in hydrofluoric acid, and is fused by alkaline carbonates. Silica, or quartz, crushed and graded to various sizes, is used in making sandpaper and sand belts, for frosting glass with sand-blast apparatus, and for other abrasive purposes. It may also be fused in the electric furnace to produce laboratory crucibles.

WATER RATE OF ENGINE

The water rate of a reciprocating engine is commonly expressed in pounds per indicated horsepower (I.H.P.) per hour. In making a test for the water rate or steam consumption, the indicated horsepower of the engine is computed from an indicator diagram, and this, divided by the total weight of dry steam supplied to the engine per hour, will give the water rate. Sometimes the water rate per delivered or brake horsepower (B.H.P.) is given. In this case, the horsepower delivered by the engine is measured directly by an absorption dynamometer, and this is used in place of the indicated horsepower in the computation.

ELECTRO-POSITIVE

Of the various methods used to protect iron from corroding or rusting, the application of a zinc surface is one of the most effective. This is due to the fact that zinc is one of the few moderate-priced metals which is electro-positive to iron. To understand the meaning of this statement, it is necessary to know what takes place during the corrosion of a piece of iron or steel that is protected by a coating of some other metal. The corrosive action is started by the setting up of a galvanic electric current, which results in carrying metal to the negative pole of the electrolytic cell. In the case of zinc, which is electro-positive to iron, a galvanic action of this kind causes a slight depletion of the zinc at points where such an action is proceeding, but does not damage the iron. With iron or steel products covered with a coating of some metal which is electro-negative to iron, the result of such a galvanic action would be the reverse; namely, there would be a depletion of the iron beneath the coating of the second metal which covers the work. It is of interest to note that the corrosive action caused by a galvanic current can only take place where there is a flaw in the coating of zinc or other metal with which the iron is covered, that allows moisture to gather. But as it is practically impossible to produce a coating in which there are not at least a few very small openings, the effect of the galvanic action that takes place at such points becomes a matter of importance.

STEAM METAL

Alloys suitable for steam valves and other purposes where the metal is exposed to the action of the steam are often known as "steam metals." Alloys of copper and zinc are unsuitable for this purpose, because their strength is materially reduced at high temperatures and the metal deteriorates by continued heating and cooling. Alloys of copper with from 10 to 12 per cent of tin are, therefore, used for this purpose. A good composition consists of 88 per cent of copper, 10 per cent of tin, and 2 per cent of zinc. This alloy has a tensile strength of about 33,000 pounds per square inch, when cold, and over 30,000 pounds per square inch, when heated to 400 degrees F.

Fuel Oil Handling Equipment

By C. C. HERMANN

IN planning a fuel oil system for forge shop use, special attention should be given to certain parts of the equipment. The fuel oil is delivered in tank cars containing from 8000 to 10,000 gallons. These tank cars often contain a surprising amount of foreign matter, such as rivets, nuts, bolts, old coats, and gloves, which have been left by workmen when making repairs. Should any of this material find its way into the pipe lines of the pump system, considerable damage might be done to the pump, to say nothing about the cost of disconnecting sections of the pipe in order to remove the obstruction. To avoid trouble of this kind, some sort of strainer should be installed in the unloading line.

Strainer for Oil-pipe Line

The strainer in the unloading pipe is not intended to remove small slugs, sand, and silt from the oil, as this may be accomplished by individual strainers at the furnaces. To attempt to remove all such foreign matter at the unloading station would mean unnecessarily prolonging the time required to unload the oil from the car. The strainer at the unloading point, therefore, should be only fine enough to remove the coarser particles of matter or such objects, as would injure the pump or clog up the pipes, where the oil is unloaded by gravity.

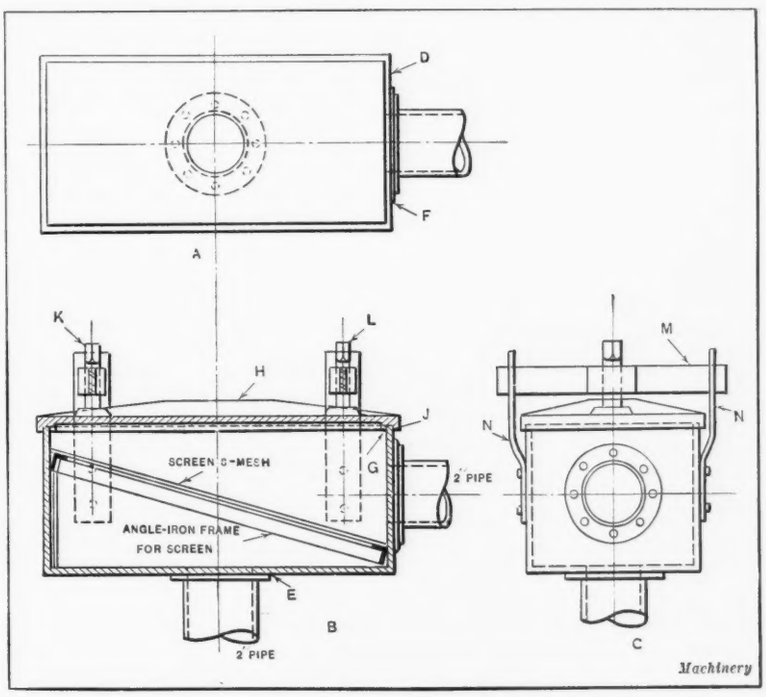


Fig. 1. Strainer for Oil Tank Car Unloading Pipe

In Fig. 1 is shown a design of unloading strainer employed by the writer in a number of installations. This strainer is constructed in a unit, with a capacity sufficient to handle a tank car of oil under the most adverse conditions. Strainers of this design are in use in a number of plants, and embody some very desirable features, among which may be mentioned the ease with which they can be cleaned and installed, rigidity of construction, which enables them to withstand severe service, and simplicity, which makes replacement expenses very small.

A plan view of the strainer is shown at *A* in Fig. 1, a side elevation section at *B*, and an end elevation at *C*. The main body or box *D* is cast from a pattern either in gray iron or semi-steel. The main dimensions of the box are as follows: Length, 16 inches; width, 10 inches; and depth, 10 inches. Sufficient metal is left at points *E* and *F* for machining the flange connection, and at the top edge *G*, which must be also machined in order to obtain a smooth surface on which to clamp down the lid *H*. This lid is cast in gray iron, and contains a groove *J*, which receives the top edge of the box. The top side of the lid is ribbed in order to give strength without excessive weight. Bosses are also cast on the lid, which are spotted to receive the ends of the lid clamping screws *K* and *L*. The clamping screws are threaded to fit the tapped holes in the bars *M*, which are held in the brackets *N*.

Brackets *N* have rectangular slots cut in their upper ends to receive bars *M*. The brackets are bolted to the sides of the box *D*. The groove in the lid is partly filled with lead, in order to seal the box when the lid is clamped down. The strainer element is shown in the side sectional view at *B*. It consists of a piece of eight-mesh copper wire screen of heavy gage, preferably 10 or 12 gage, secured on a frame made up of 1 1/2- by 1 1/2- by 1/4-inch angle-iron. An angle-iron is also bolted to the inside of the box which supports the screen, so that it is not necessary to bolt the screen directly to the box. Instead of bolting an angle-iron to the box, the screen may be supplied with upright legs at the high end. When the latter construction is employed, the screen can be simply set into the box and removed without tightening or loosening bolts or nuts.

Cone Type of Strainer

In the upper view, Fig. 2, is shown another design of oil strainer for unloading station work. This is simpler and cheaper to construct than the strainer shown in Fig. 1. It was designed by the writer, and has proved fully as effective as the design previously described. It consists of four principal parts, namely the flanged pipe *A*, the two reducers *B*, and the strainer *C*.

The section *A* is a 6-inch flanged pipe, 8 inches long, which is fitted between two 6- by 3-inch reducers *B*. One end of the flanged pipe is machined to receive the screen *C*, which is made of 10-gage sheet metal punched with a series of 1/4-inch holes and formed in the shape of a funnel. The edge of this funnel is flanged and riveted to a steel ring which fits between the flanges of the pipe and reducer as shown.

In order to remove the screen for cleaning, the flange bolts are withdrawn and the reducer at the left pulled back. As the screen is in the shape of a funnel, with the pointed end toward the inlet or car side, it has a large screening surface, as well as great strength. Strength is an important consideration, as the strainer must withstand a considerable pressure if it becomes clogged with foreign matter. This pressure is caused by the head of oil in the tank car, the head depending upon the height of the surface of the oil in the car above the level of the strainer.

In the lower view, Fig. 2, is shown still another type of strainer employed at an unloading station. This is similar to the one shown in the upper view, except that a by-pass is provided, which may be opened in case the screen becomes clogged and there is not time for the unloading operations to be held up while the strainer is removed and cleaned. There

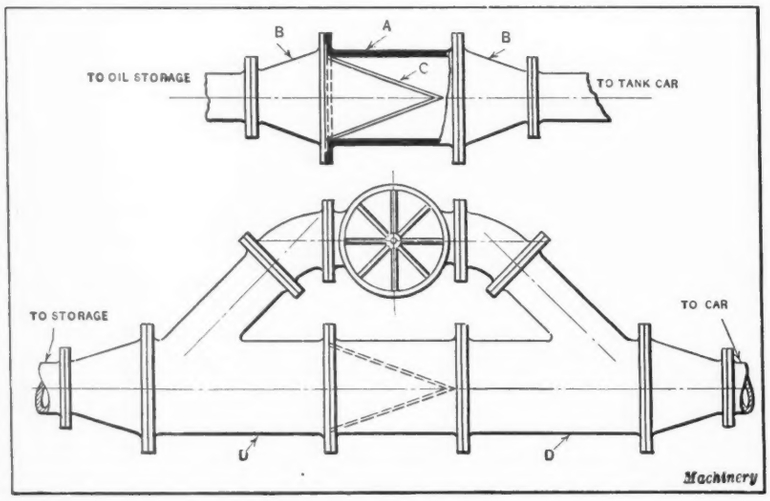


Fig. 2. Oil-pipe Strainers

is another advantage in providing a by-pass in the system. Should the screen become clogged, the pipe from the screen to the car connection would be full of oil, and unless this oil could be drained off to the storage tank by means of the by-pass, the oil contained in the pipe would be lost when the screen was removed. Besides the loss of the oil, it causes an untidy condition about the unloading station. It is not uncommon to have the screen clog up two or three times during the unloading of a single car of oil.

The strainer shown in the lower view, Fig. 2, requires two flanged Y-joints *D* reducing from 5 inches to 2 inches in the branch members. The cone or funnel-shaped screen is the same as the one shown at *C* in the upper view. The two branches of the Y members are connected by two ells and a gate valve. The gate type of valve is employed, because it is either left wide open when the by-pass is in use or is entirely closed, at which time the resistance is minimum.

Hose for Tank Connection

An important piece of equipment required at the unloading station is the connection hose. This part is standardized, and consists of a special steel hose usually supplied with a brass coupling at one end which fits the outlet on the tank car, and a hose coupling at the other end for making connection with the oil strainer. The hose has an internal diameter of 2 inches and is 6 feet long. Under ordinary conditions, this size will discharge a tank car of average capacity in about two hours. Hose of larger diameter and greater length may be obtained to meet special requirements.

Any plumber who has attempted to connect a tank car with an unloading station by means of pipe and regular fittings will readily agree that this method is not practical. Too much time is required to make the various connections, the car must be spotted or stopped in exactly the right position, and the pipe fitting must be done in close quarters. A straight pipe may be used in connection with a short piece of flexible hose, in which case a swivel joint should be used in the pipe to permit it to be swung out of the way when not connected with a car. Swivel joints are objectionable, however, as they require frequent repairs, such as repacking, when left out in the open. Considered from all angles, the flexible hose is preferable for unloading purposes.

Steam Coils for Heating Oil

Tank cars are provided with heater coils to which a steam connection may be made for heating the oil. During the late fall and winter months in the central and northern parts of the country, the oil becomes too heavy to flow readily from the car by gravity. From one to three hours heating may be necessary to thin the oil, and a steam connection should, therefore, be provided at the unloading station. The length of the steam hose should be sufficient to reach the tank car connection. For this purpose, a flexible steel covered hose is preferable, as it must be exposed to the weather and must be dragged about over the tracks and ground. The heater coil outlet in the tank car should be opened slightly to permit the condensation to escape from the coil when a return connection is not provided. The globe valve may be cracked open slightly and the condensate allowed to run off to the sewer drain. By providing a return connection at the unloading station, which is provided with a steam trap, and by using a steam hose between the trap and the return end of the coil in the car, the condensate may be saved.

The oil-strainer discharge pipe projects down from the strainer box, as shown in Fig. 1, and is preferably run in a conduit or tunnel to the storage tank. In the case of the strainer shown in Fig. 2, an ell is placed on the discharge end and the pipe taken underground, the same as with the strainer shown in Fig. 1. The discharge line should be amply large; the minimum size for tank car unloading is 2 inches, and a 3-inch pipe is preferable. This pipe should be as straight as possible, that is, it should have no sharp bends, ells, or other fittings that would tend to retard the flow of oil. One valve in the line is all that is required, and this should be located just under the strainer so that the latter may be removed and the pipe closed off to prevent dirt or other foreign matter from finding its way into the pipe line.

As a steam pipe is run to the unloading station, it may just as well be placed close to the discharge pipe, so that it will keep the oil in a fluid state and cause it to flow more freely. In some cases, it is advisable to enclose the oil discharge pipe and the steam pipe in the same insulation casing, in order to conserve the heat radiated along the line. If this is not done, the steam line, at least, should be covered.

Unloading Station Plans

Some kind of protection against the weather should be provided for the unloading station. A cover over the strainer of sufficient size to contain the steam and oil hose as well as the car connections, which are different for various cars, and a set of wrenches to fit the screws on the strainer cover should be provided. The tank cars that are being unloaded should be protected against the danger of being moved by the switching engine crew. This may be accomplished by the usual derail placed ahead of the car, with a signal that

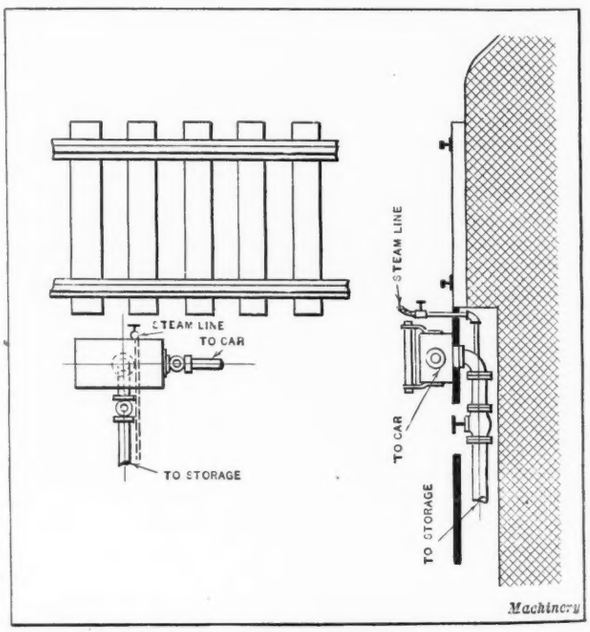


Fig. 3. Tank Car Unloading Station

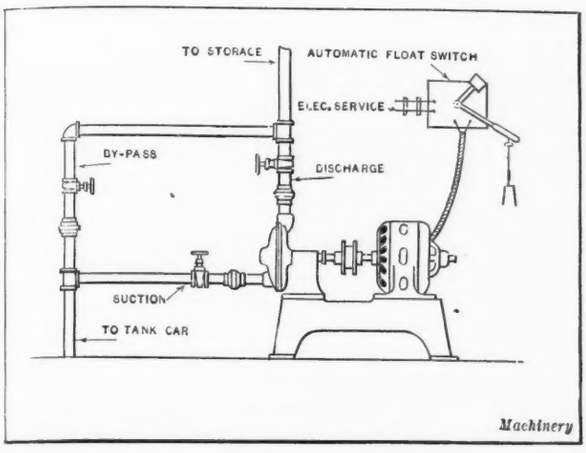


Fig. 4. Pump Installation for Tank Car Unloading

indicates that the line has been set against the entry of additional cars. The switching crew will ordinarily pay more attention to a derail than they will to a block of wood placed on the rails. The use of a derail is an effective method of eliminating the necessity for making frequent removals of the flexible hose at the unloading station. Another way to protect the car is to provide a special unloading switch for the cars that are connected to the storage tanks and lock this switch against entry.

Difficulty is often experienced in getting the switching crew to spot the cars at just the right place. If this is not done, extra labor is required to move the cars by hand in order to bring them within reach of the unloading hose. In order to eliminate this trouble and avoid lengthy and continued explanations to the various switching crews, a pointer was located between the rails. This pointer worked on a hinge, so that it could be swung up into position. A sign board was then placed at the unloading station, bearing instructions to spot cars so that the oil-pipe connection would be over the pointer. After this pointer was provided, it was only necessary once in a great while to move the cars by hand in order to connect the unloading hose.

In Fig. 3 is shown an elevation view of an unloading station embodying the desirable features referred to. By slighting details or eliminating any of the desirable elements in the unloading station, any initial saving that can be made will be offset and losses generally encountered through waste of oil when the equipment is placed in use. For instance, a certain oil unloading station consisting of the usual storage tank installed directly beneath the unloading track proved unsatisfactory and wasteful. A 4-inch pipe was installed in the tank, which extended up between the car track rails and ended just above the level of the ties. A large funnel was provided which had a coarse-mesh screen at the end of the projecting pipe.

The object was to spot the tank car so that the unloading connection would be directly over the funnel, and then open the valve and allow the oil to run into the tank through the funnel. This installation was not successful, as the screen would clog up and much oil would be wasted before it could be shut off. The connection between the tank car and the storage tank should be tight in order to avoid loss of oil. The unloading station equipment shown diagrammatically in Fig. 3 is employed when an underground storage tank is used which permits the oil to flow by gravity directly to the tank. When the consumption is moderate, this type of storage is practical. However, when the consumption is high and a number of tanks are required, the storage above ground is generally preferable.

Oil-pump Installations

It is advisable to make all storage tank connections at the top of the tank. This may be done in the case of underground tanks which are unloaded by gravity. However, there are many installations in which the oil must be pumped from the tank car and raised to the top of the tank. In such cases, a pump must be installed in the unloading station. For this service, it is not so necessary that there be a uniform flow of oil without pulsation as is the case with pumps furnishing oil to the burners, but the pump must have a suitable capacity. The average tank car contains 8000 gallons, which should be unloaded in approximately two hours. A pump handling a 2-inch suction line, rated at about 70 gallons per minute against a head of 20 feet, consumes but one horsepower. This pump is of the centrifugal type and serves the purpose very well. The piston type pump may also be utilized. Such pumps work at their full capacity due to the suction being placed above the discharge, so that the flow of oil from the pump is assisted by gravity. When possible, the pump should be raised to the car level.

A strainer in the suction side of the line is imperative when the oil is handled by a pump; otherwise, loss of oil or damage to the pump is bound to occur sooner or later when foreign matter becomes clogged in the suction end. Most pump manufacturers guarantee their products only when a screen is provided for the suction line. It is well to mention here that all oil-pumps should be provided with a safety relief valve as a protection to the pump and the system.

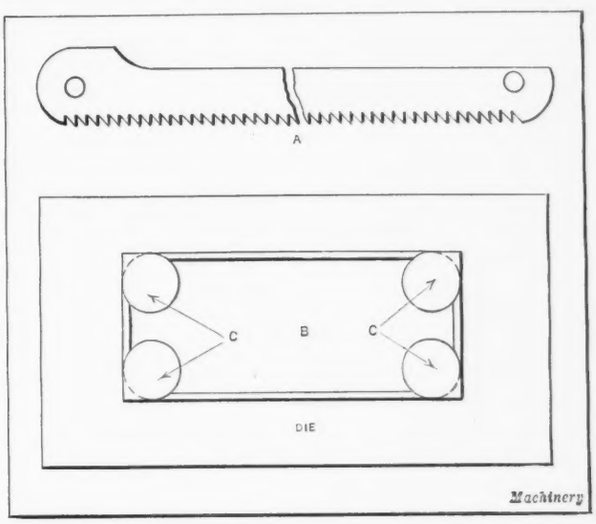
In Fig. 4, is shown an unloading system in which a centrifugal pump is incorporated for the purpose of raising the oil to the storage tank. The pump is provided with a by-pass containing a relief valve, set to prevent the pressure in the discharge line from exceeding a given figure—usually 40 pounds. Should the discharge line become closed, the pressure will build up to 40 pounds and the oil will then be discharged back into the suction line through the relief valve. This feature is particularly important when motor-operated piston pumps are employed, as otherwise the pressure will be built up until breakage of some part of the equipment occurs. Steam-operated piston pumps would simply build up a pressure equal to the steam pressure within the steam cylinder and then stop, thus avoiding possible damage to the system.

* * *

CUTTING OPENINGS IN DIES

By CHARLES KUGLER

Instead of drilling a series of holes in a die blank in order to remove the core, time can often be saved by cutting out the metal with a power hacksaw. For work of this kind, the writer uses a hacksaw blade with the back edge cut away, as shown at *A* in the illustration. When a die with a square opening is being made, as indicated in the lower view of the illustration, four 1/2-inch holes *C* are drilled, as indicated, and the saw passed through one of these holes. It is then an easy matter to cut out the core *B*. This method should be used only when machines are available for finishing the opening in the die to size, as too much metal would be left to permit finishing with a hand file.

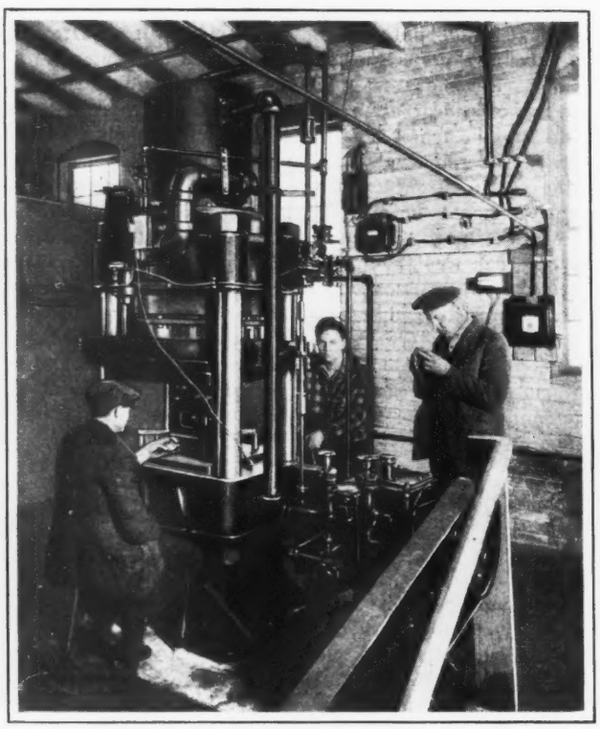


(A) Hacksaw Blade with Back cut away; (B) Core cut from Die

HOT-PRESSING SOFT-BASE METAL BEARINGS

Bearings for automobile and stationary engines, electric motors, compressors, pumps, etc., are hot-pressed from soft-base metals by the Hydraulic Pressed Bearing Co., Niles, Mich. The metals are pressed at a temperature that is low enough to leave their physical characteristics unchanged. The use of stock in the solid state is claimed to prevent segregation of the elements in the metals and to eliminate blow-holes, fissures, and strains. Machining operations are not required, because the bearing is turned out from the press ready for service.

The machine used in forming these bearings is an Oilgear four-column speed press. This press has a rapid approach to the work of 100 inches per minute, and a quick return of 200 inches per minute. Ten strokes, 6 inches long, can be made per minute at a pressure of 200 tons. The Oilgear pump that actuates the press is equipped with a pressure



Pressing Bearings Hot from Solid Stock

variometer by means of which the line pressure can be conveniently adjusted between 300 and 1000 pounds per square inch. In working the press, the operator must use two handles. This feature eliminates any possibility of one of his hands being caught under the ram.

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LEARNING A TRADE

An attractive booklet entitled "Learning a Trade," published by the Pratt & Whitney Co., Hartford, Conn., contains some valuable suggestions for a young man preparing to choose his life work. Under the heading "Choosing a Job," the fact is pointed out that home influences unfortunately often work against a boy's natural desire to become an expert mechanic. Many parents think that their sons should look for "white collar" jobs immediately after leaving school, without stopping to think what future there may be in a job taken temporarily. This feeling is gradually giving way before the knowledge that any young man who receives a fundamental training in a trade, even though he does not intend to follow that trade all his life, has gained a foundation that will stand him in good stead in his future life. The many successful men who started as apprentices prove it. A copy of this book will be sent by the company to any young man who is contemplating obtaining a thorough training in the machinist's, patternmaker's, or molder's trade.

REPAIRING CYLINDRICAL GRINDING MACHINES

By JACOB H. SMIT

Cylindrical grinding machines should always be kept in good condition, because of the close limits to which most pieces of work must be ground. In order to move a heavy slide a fraction of a thousandth of an inch, the bearing surfaces of the slide, the thrust collars of the feed-screws, etc., must be true. If a machine is not used frequently, the slide mechanism will bind, with the result that the slide, instead of moving an amount corresponding to the movement of the feed-screw, will remain stationary and then, after another slide adjustment, jump ahead too much and dig into the work. To secure good results, a slide should be fed through the entire length of its movement when oiling.

As on any other machine, the thrust collars of the feed-screw should be smooth; otherwise, erratic movements of the slide will result. In one shop where the writer was employed years ago, many small pins 1/8 inch long had to be ground within limits of 0.0001 inch. The toolmakers used to grind these pins on an old cutter grinding machine which was in such a bad condition that for every pin ground correctly, two or three were spoiled. Having to do some himself, the writer experienced the same results as the other toolmakers. Then he took off the feed-screw and slide to find out what the trouble was. The slide was all right and the feed-nut was tight in the hole, so that the feed-screw was evidently at fault. The bearing for the feed-screw at one end was worn slightly loose, and the thrust collars were grooved annularly. In revolving the feed-screw, the grooves and thrust collars would alternately coincide and ride on the high ridges between, thereby producing an erratic movement of the slide. By facing the collars and the surfaces with which they contacted, the machine was put in good condition and ground the pins with little loss through spoiled work.

Refitting the Slides

In repairing cylindrical grinding machines, disassemble the cross-slide and scrape its dovetail, using a piece of machine steel or cast iron scraped to suit, for both the testing and the scraping. The male and female members should be scraped separately, and then together with the gib in place. In re-assembling this slide, care should be taken in making the adjustments. Adjust the center gib screw first, moving the slide by hand to determine the "feel." After this, tighten up all the screws, starting in the center and tightening the screws alternately on both sides. Then loosen the screws slightly and make the final adjustment by tightening one screw at a time, moving the slide by hand with each tightening to note the "feel." Put lock-nuts on the gib screws if they are loose in their tapped holes. The wheel-slide of a cylindrical grinding machine should be an easy fit without shake.

Examine the feed mechanism and all thrust bearing faces for possible defects, and make any necessary repairs. If the headstock spindle is loose in its bearings, much trouble will result from this source. A light grinding cut should be taken off the spindle in the same machine by replacing the spindle with an arbor for supporting it in conjunction with the tailstock. Scrape the bronze bearings to suit.

If the grinding spindle needs repair, take a light grinding cut on its journals in another machine. If no grinding machine is available, simply lap the bearings if the journals are straight and hardened. File the fiber, wood or brass separators of the taper bearings as required, and do not forget to put them back.

If the tailstock spindle is badly worn, grind it straight and bush the tailstock to suit, or else bore or ream out the hole in the tailstock and make a new spindle. If there is play between the bottom of the keys in the tailstock and the slots in which they slide, straighten the slot and supply new keys. If the longitudinal slide is badly worn, scrape that also. The overhauling of a used machine tool is sometimes assigned to second- or third-class mechanics, whereas the best machinist is none too good for such important work.

What MACHINERY'S Readers Think

on Subjects of General Interest in the Mechanical Field

APPRENTICESHIP AND SPECIALIZATION

There has been much discussion on the subject of training help for the manufacturing industries, especially for the machine shop, where there is an ever-increasing demand for skilled help to run special machines or specialize on standard tools, in order to get the most out of them. In the education of a specialist in medicine or law, the student must complete a general course covering the whole subject before he is eligible for a post graduate or special course, and why wouldn't this be good in machine shop practice?

A specialist should know, at least in a general way, what operations are performed on a piece before and after it reaches him, so that he can do his work intelligently. Another advantage of a general mechanical training is that it makes a man better able to fill a position of responsibility, such as that of foreman, because he will have the ability, himself, to do the work that he is supervising. When he specializes on one type of machine, he is hampered by lack of knowledge if he is put in charge of other work. In the art of mechanical drafting, a man is badly handicapped if he lacks actual experience in machine shop practice. My idea is that every man working at the drafting-board should have at least a year's experience in the shop to gain first-hand knowledge of the things he designs. This would decrease the number of impracticable designs for which industry pays.

On many specialized machines and tasks, operators have a chance to make extra pay, either through piece-work or the bonus system, which they would not have otherwise. Through specialization, work is done much more quickly and generally better, and the operator has a chance to make extra money, which to him is of paramount importance. However, it should not be inferred that everything should be specialized. We all know that the all-around mechanic is, and always will be, a necessity, and the man who has the fundamental mechanical training, whether he is a specialist or not, is the man who will be in line for something better when the opportunity offers.

WILLIAM C. BETZ

WORKMEN SHOULD KNOW PLANT LAY-OUT

Instruction of men in a factory seldom extends beyond the actual work on which they are engaged. Advantages that may be derived from the workmen becoming conversant with the general plant lay-out and equipment are worthy of more consideration on the part of shop officials than might be generally supposed.

One very important factor in shop lay-out and management is the provision of some method of identifying the numerous piping installations that are now so common in the average manufacturing establishment. In addition to classifying different lines of piping by means of some color arrangement, charts should be made and placed in conspicuous locations about the shop, so that employes may be able to act quickly, in an emergency, to avoid destruction of life and material.

A few years ago, while the writer was working in a large sheet metal plant, an experience met with emphasized the advantages that would result from the workmen having a better knowledge of shop conditions and current developments. For several weeks prior to the time in question, pipe-fitters had been engaged in installing a new sprinkler system throughout the various departments.

The climax came one night when four or five toolmakers were working over-time. The day previous the water had been turned on in the system to test the piping, and apparently everything was satisfactory. This night, however, while one of the men happened to be in a comparatively isolated portion of the factory, he observed water dripping from the ceiling above. Upon advising the foreman, the latter investigated, and going to the floor above, found a large area already covered with water, which flowed freely in many places from the second-story ceiling.

Continuing up to the third floor he found a section virtually flooded to a depth of two or three inches and a stream of water running from a large drying kiln. The foreman immediately endeavored to stop the flow from the released sprinkler, but the force of the water was too great.

It was just here that the lack of a general knowledge of the plant lay-out and equipment resulted in considerable additional damage to much of the finished tinware and wire articles that covered the floors in the vicinity of the "blow-out." The few men then on the premises did not know where to shut off the source of this water supply, and telephone communication was necessary to bring the superintendent to the scene, before the yard valve could be closed. During this interval, the toolmakers were busily engaged bailing water from the floor and pouring it into nearby sinks.

The cause of the "break" was the placing of a 180-degree sprinkler head in a kiln that very often was raised to a temperature of nearly 200 degrees. If the men working at the time had known the locations of the different valves, much time and loss would have been avoided.

JAMES R. HENDERSON

STARTING RIGHT IN STANDARDIZATION WORK

It has often seemed to the writer that in standardizing machine details and machine shop methods, the cart is frequently put before the horse. Of course, present standards that are in general use should be accepted as far as possible, but in cases where there is no generally accepted standard, the ideal methods should be adopted rather than methods that would meet the requirements of a minority of users or makers, or that would answer some temporary convenience.

For example, in adopting a tolerance system, no attention need be given to the present allowances or limits on reamers. The tolerance system should be adopted with a view to producing the very best results as regards interchangeability and proper fits. It is a very simple matter for the reamer makers to adapt the allowances and tolerances on their reamers to a universally accepted system of fits and tolerances in machine building.

On the other hand, of course, in all standardization work one must consider whether the tools to be used can be commercially produced. In the case of limits and tolerances for screw threads, for example, it would be possible to adopt a system of tolerances that would be ideal as far as the finished machine is concerned; but it might be impracticable to obtain such limits and tolerances in the tools by which the threads are produced—that is, in commercial taps and dies. This is a subject that has been quite thoroughly discussed in the past in connection with the adoption of the now accepted tolerances for screw threads and need not be further discussed here.

To sum up, in adopting standards, sound judgment must be used so that, on the one hand, we do not tie our hands by an unnecessary regard for existing tools and conditions, and on the other, do not disregard the possibilities of producing the standardized articles commercially.

V. E.

ELLIPTIC SPRING CHART

By ELMER LATSHAW

In designing elliptic springs, it may be necessary to compute the stress and the number and size of the plates several times before a suitable spring is obtained. The accompanying chart will be found useful in making these calculations, as it reduces the arithmetical work to a minimum. The chart is plotted for a fiber stress of 100,000 pounds per square inch, and the radial load lines represent pounds per inch of width at one end of the spring plates. The following examples will show how the chart can be used in solving problems that arise in designing elliptic and semi-elliptic springs.

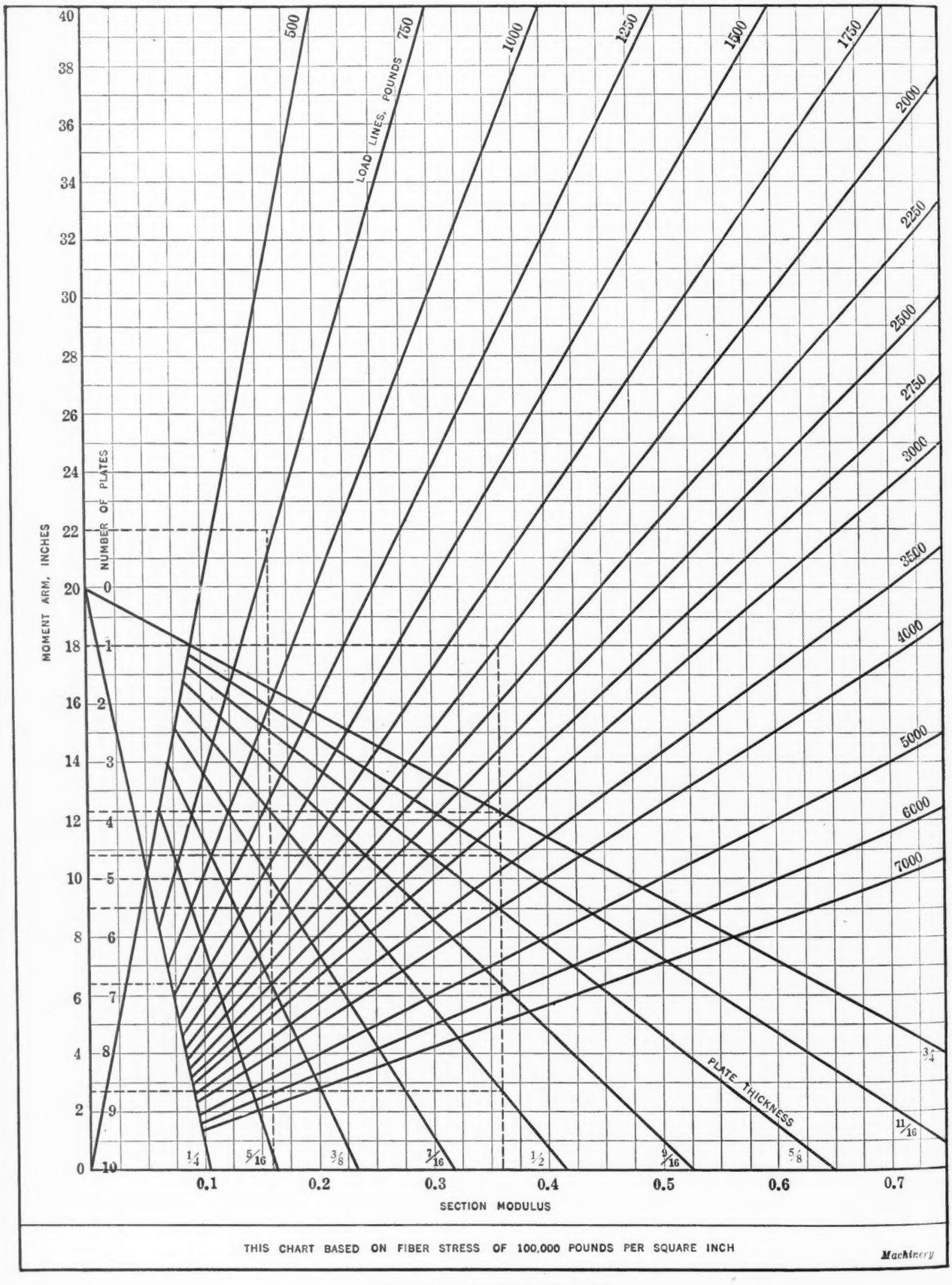


Chart for Use in designing Elliptic Springs

Example 1—What will be the thickness and number of plates required for a semi-elliptic spring that is to carry a load of 16,000 pounds at a fiber stress of 100,000 pounds per square inch, when the center distance is 40 inches, the bands 4 inches wide, and the plates 4 inches wide?

Solution—The effective moment arm is equal to one-half the difference between the center distance and the width of the band. Thus the moment arm equals $(40 - 4) \div 2 = 18$ inches. The load per inch of spring plate at one end is $16{,}000 \div (2 \times 4) = 2000$ pounds. Following the 18-inch moment arm line to the 2000-pound load line, we find that they intersect on the vertical section modulus line 0.36. Following this line up to the 3/4-inch thick plate line, and from the point of intersection following the horizontal line to the left, we find by the column headed "Number of Plates" that 3.85 plates are required. In this case, of course, four plates would be used. Then the stress would be $3.85 \div 4 \times 100{,}000 = 96{,}000$ pounds per square inch. Likewise, the number of plates and stress can be found for other thicknesses of plates.

Example 2—What load will a five-plate, 5-inch by 7/16-inch semi-elliptical spring carry under a fiber stress of 100,000 pounds per square inch when the center distance is 50 inches and the bands 6 inches wide?

Solution—The moment arm in this case would equal $(50 - 6) \div 2 = 22$ inches. Following the five-plate line on the chart to the right until it cuts the line representing the 7/16-inch plate thickness line, we find the section modulus directly under this point at the bottom of the chart to be 0.16. Tracing up this line we find that it intersects the 22-inch moment arm line at a point near the 750-pound load line. As this point is slightly to the left of this line, the load is estimated to be 725 pounds. Thus the capacity of the spring under a fiber stress of 100,000 pounds per square inch equals $725 \times 5 \times 2 = 7250$ pounds. This value is arrived at by multiplying the load of 725 pounds by 5, which is the width of the plates, in inches, and multiplying the result thus obtained by 2, as there are two ends to the spring. If it is desired to determine the capacity at a fiber stress other than 100,000 pounds per square inch, the problem becomes one of simple proportion.

The chart shown is plotted for springs of the size and type used for railway trucks, but a similar chart can be easily constructed for springs for greater loads, which require more plates. If many springs are to be designed, all of which have plates of the same width, the chart can be modified to eliminate the necessity for finding the load per inch of plate width at the ends, thus further simplifying the calculations.

In the use of this chart it is, of course, assumed that the plates of the springs are graded in length and tapered at the ends to give a uniform stress on all plates, as the chart is based on the assumption that the carrying capacity is directly proportional to the number of plates in the spring.

* * *

DEVELOPMENTS IN THE DESIGN OF TEXTILE MACHINERY

In a report on the progress in textile mechanical engineering, presented before the American Society of Mechanical Engineers by the Textile Division of the society, it was pointed out that the principal developments in textile machinery design at the present time are: Adaptation of existing machinery for processing new or lower-grade fibers; refinement in design and construction of all textile machinery; trend toward standardization of textile machinery; arrangement of machinery in sequence or "range" wherever processes permit (this has been particularly marked in finishing equipment where variable and automatic speed control is an essential element); development of drying equipment for higher production speeds than have been practicable in the past; application of centralized control of lubrication on heavy machinery such as calenders; improved equipment for mixing and blending of different kinds of raw stock; and development of improved clutches for machine drives.

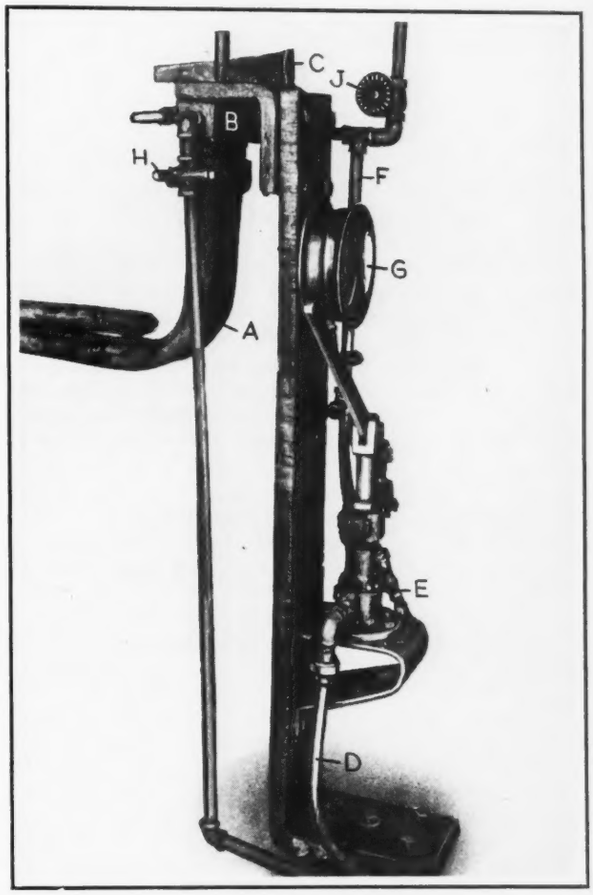
TESTING SUPERHEATER UNITS

By E. A. MURRAY, Shop Superintendent
Chesapeake & Ohio Railway Co.

It is customary and, in the writer's opinion, necessary to thoroughly inspect and test all superheater units while they are out of the boilers. The hydrostatic test, which is the usual one, can be quickly applied with the device here illustrated. The method of using this test rack is as follows:

The unit *A* to be tested is connected temporarily to an improved header *B* by the use of a key bolt and key *C*. The shop water line connects with a 1/2-inch pipe *D* which, in turn, is attached to the intake side of hand pump *E*. Another 1/2-inch pipe *F* leads from the discharge side to header *B*. Check valves are located on the intake and discharge sides of the pump cylinder.

Water is allowed to flow to fill the superheater unit; then the valve in the filling line is closed and the hand pump is



Simple Form of Apparatus for applying Hydrostatic Test to Superheater Units

used to apply the testing pressure. From 200 to 300 pounds per square inch can be obtained by two or three strokes of this pump, and this pressure is sufficient for testing the unit. The steam gage *G*, having a pressure range up to 300 pounds per square inch, is used to indicate the pressure. While a unit is being tested, valve *H* in the exhaust pipe is opened, and also valve *J* in an air pipe which admits compressed air to the unit and forces the water out of it through the discharge pipe. After the test is completed, a valve in header *B* is opened while the unit is being filled with water, to permit the air in the unit to escape.

* * *

The lumber used annually by the Fisher Body Corporation, maker of automobile bodies, one of the subsidiary concerns of the General Motors Corporation, exceeds 300,000,000 board feet or 20,000 carloads. It is estimated that this amount of lumber would be sufficient for building homes to house the population of a city of 100,000 inhabitants.

The Cost of Unnecessary Accuracy

A NUMBER of editorials that have been published from time to time in MACHINERY have pointed out that the waste of unnecessary accuracy, when accuracy is not required, may be just as great as the waste due to lack of accuracy when accuracy is a necessary requisite. Recently some specific instances of excessive accuracy and its cost were brought to our attention. These examples will doubtless prove of great interest to MACHINERY'S readers, and will emphasize the need for good judgment in deciding as to when and when not close tolerances are required.

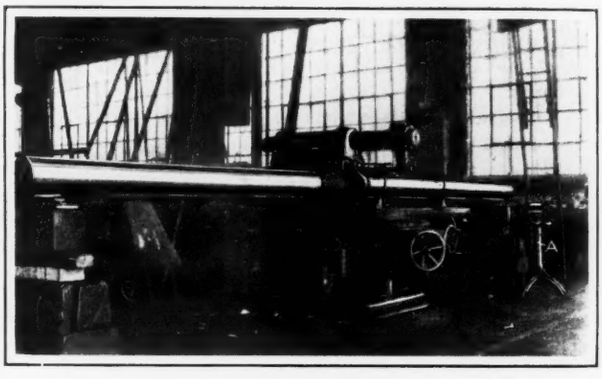
A firm manufacturing small tools recently received an inquiry for a metal slitting cutter of the circular disk type. Tolerances were specified to plus or minus one-half a ten-thousandth of an inch. The tool manufacturer quoted $100 a piece for these cutters. The customer immediately wrote back pointing out that the price was excessive. The tool manufacturer asked the customer to specify the purpose for which the tools were to be used, and requested that he be permitted to use his own judgment as to the accuracy required. If the cutters, when so made, were not satisfactory, he agreed to stand the entire expense. The result was that perfectly satisfactory cutters were made with tolerances of plus or minus one-quarter of a thousandth of an inch, which reduced the cost per cutter to $4. The customer's engineers apparently had no conception of the accuracy that was actually required for the work for which they were buying tools, nor did they appreciate the cost of the accuracy they demanded. By reducing the accuracy to practical requirements, the cost was decreased from $100 to $4 a piece for the tools.

In another case, the customer wanted to buy a ring gage of a certain size that was to be straight and round to within a limit of plus or minus one hundred-thousandth inch. The gage maker quoted $2500 for making such a gage, and felt that he was taking a chance at that. The customer thought the price was excessive, and after some correspondence, decided that an accuracy of 0.0001 inch would be satisfactory. This made it possible to make the gages with a profit for less than $350.

In another case, a blueprint was submitted to a manufacturer calling for a screw over 20 feet long, 3 1/2 inches in diameter, having four Acme threads to the inch. The tolerance on the pitch diameter and lead per inch was given as plus or minus 0.0001 inch. In order to show how extreme these requirements were, a quotation of something more than $10,000 was made for the screw. It was estimated that, on account of the size of the screw and the difficulty of handling it, the setting up for making dependable measurements of a pitch diameter and lead error to within the limits required, would have cost about $20 per measurement. The interesting thing in this case is that there was no need for accuracy whatsoever. If there had been a 1/16 inch tolerance on the diameter of the screw either way, it would have made no difference in its application, because the nut was to be fitted to the screw by the manufacturer who made the screw, and so long as the two fitted together, there was no question of interchangeability, because only one screw and nut were to be made. Finally, more reasonable tolerances were set on this screw, and it was made for $315, instead of thirty or forty times that amount.

Frequently draftsmen dimension fillets in decimals, indicating that great accuracy is required. The tool manufacturer generally knows that no accuracy is demanded in regard to the fillets, but if he were to follow the drawing exactly, he would make the tools with such unnecessary accuracy as to increase their cost several times. If a fillet is marked 3/16, it is clear that no great accuracy is required, but when it is dimensioned 0.1875, it would appear that an accuracy to the fourth decimal figure is wanted. As a matter of fact, a dimension of 0.15 or 0.2 inch would be just as good. One tool manufacturer stated that he believed that 20 per cent of the manufacturing costs in the metal-working industries in the United States are due to carelessly set tolerances and what he termed "foolish tolerances" and "unnecessary accuracy." This particular manufacturer finds it necessary to turn down over half a dozen inquiries every week, because of the extreme tolerances demanded, which place the tools outside of the scope of commercial manufacturing and in the laboratory class.

As just one more example of the cost of unnecessary accuracy may be mentioned the case of a tooling equipment on which a manufacturer quoted; there were four dimensions that were carried to the fifth decimal place, with the understanding that an accuracy of plus or minus one hundred-thousandth inch was required. The tool manufacturer quoted over $35,000, but after he had persuaded the customer that the four "accurate" dimensions would serve every conceivable commercial purpose if the accuracy was to within plus or minus 0.0002 inch, the quotation was reduced to about $4000.



Cutting Keyway in Large Shaft

A prominent gage engineer recently stated that an inspection of the detail drawings in the majority of the drafting-rooms in the United States would show that manufacturing costs could be decreased appreciably if dimensions, instead of being shown in "flat" figures, were changed to show carefully thought out tolerances. This would not only facilitate and cheapen manufacture and eliminate unnecessary accuracy in the shop, but would also reduce the cost of assembling machine units and complete machines.

The conservative attitude that in many plants opposes the introduction of a drafting-room system by which limits are placed on all important dimensions on the drawings, is probably due to the fact that unsatisfactory results have often been obtained in the past, because of limits having been set without proper appreciation of the accuracy required.

* * *

MILLING KEYWAYS IN HEAVY SHAFTS

By H. K. GRIGGS

In a recent number of MACHINERY, there appeared an illustration of a milling machine with a one-ton shaft mounted on the table. The accompanying illustration shows a shaft, 9 inches in diameter and 23 feet long, which weighs nearly 2 1/2 tons. In order to prevent excessive stresses on the milling machine, stands having rolls at the top, like the one shown at *A*, were placed under the overhanging ends of the shaft. In addition to these supports, the hoist chain of the overhead crane was attached to the end of the shaft while milling the keyway.

MILLING SLOTS IN VALVE DISKS

High production rates are obtained in milling the T-slot of brass valve disk castings, such as illustrated in Fig. 1, through the provision of the equipment shown in Figs. 2 and 3. With this equipment, the work of the operator consists merely in reloading the work-holding fixture. The operation is performed on a Kearney & Trecker plain milling machine, which is equipped with a special reciprocating work-holding fixture and a head with three vertical spindles, as illustrated. Three disks are milled simultaneously on either side of the cutters, and while the operation is in process, three pieces of work are reloaded on the opposite side of the cutters.

Extending across the middle of the fixture is a member having three stationary V-jaws on each side. Opposing each of these jaws is a sliding V-jaw which opens or closes automatically, depending upon the direction in which the fixture is moving. The work pieces are clamped between the stationary and sliding jaws. When either side of the fixture advances toward the cutters, the three pieces of work on that side of the fixture are clamped, and at the same time, the pieces on the side of the fixture receding from the cutters are unclamped to permit reloading.

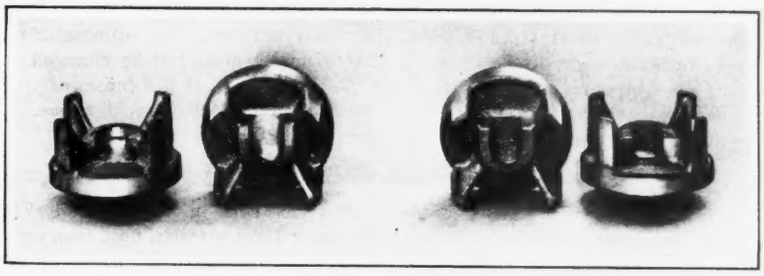


Fig. 1. Valve Disks before and after the T-slot has been milled

The reciprocating slide of the fixture is worm-driven from the regular universal joint shaft on the right-hand side of the machine. A cam moves the slide back and forth, the motion being such that the work advances quickly to the cutters, slows down as the depth of cut increases, and withdraws rapidly after the milling has been completed. In loading the fixture, the operator merely sets the valve disks on a plate. Immediately after the milling and after the valve disks have been released from the jaws, the plate on which the disks rest slides sideways, which permits the disks to drop down through holes. They are carried by the slide and the trough seen in Fig. 3 into an adjacent tote box. Eight different sizes of valve disks are accommodated in the same fixture by merely changing the clamping jaws. Obviously, different sizes of cutters must also be employed. In this operation, the production ranges from 500 to 800 pieces per hour. The spindles run at 650 revolutions per minute.

MAKING EMPLOYES STOCKHOLDERS

An employes' stock ownership plan that has some unique and interesting features has been adopted by the Geometric Tool Co., New Haven, Conn. The stock, known as Employes Prior Preferred, has a par value of $50 per share and has preference over all other classes of stock issued by the company, both as to dividends and as to assets, in the event of dissolution. It is entitled to 7 per cent cumulative dividends, but the most interesting feature in connection with it is that if the common stock pays over 10 per cent, the preferred stock is entitled to one additional per cent of dividend for every per cent paid on the common stock above 10 per cent. For example, if the common stock pays 12 per cent, the preferred stock pays 9 per cent, and if the common stock pays 18 per cent, the preferred stock pays 15 per cent. If the common stock should pay over 18 per cent, the employes' preferred stock, however, will be entitled to only 15 per cent, which is the maximum dividend in any one year.

The stock can be held only by employes of the company, and will be redeemed at par and accrued dividends if the holder leaves the employ of the company, or in case of death. Any employe whose compensation is less than $2000 a year is entitled to acquire up to twenty-five shares of the preferred stock; those earning over $2000, but less than $4000, are entitled to subscribe for not more than fifty shares; and those earning over $4000 a year are entitled to subscribe for one hundred shares. Any employe of the company who is also a director of the corporation is not entitled to subscribe.

* * *

PROTECTING RIGHTS IN SCIENTIFIC DISCOVERIES

The Northwestern University will award a prize of $1000 and a suitable medal to the author of the best essay or monograph submitted before March 1, 1928, on the protection of scientific property, that is, on the granting of some kind of patent right to the maker of a scientific discovery. The prize is known as the Charles Clarence Linthicum Award. Complete information may be obtained from the Linthicum Foundation, Northwestern University Law School, Chicago.

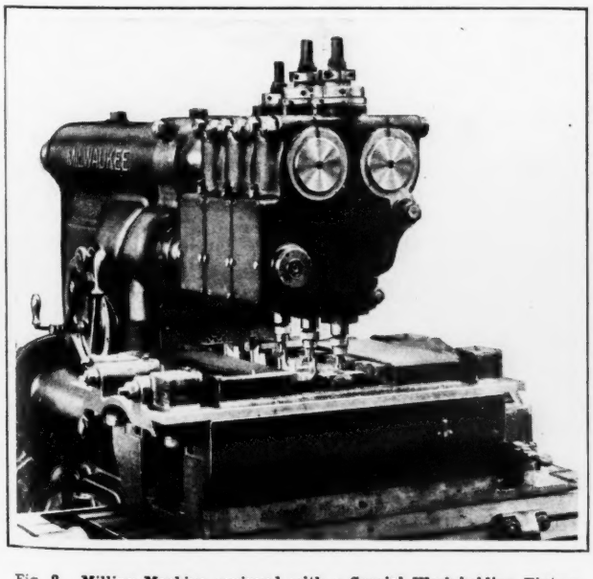


Fig. 2. Milling Machine equipped with a Special Work-holding Fixture and Three-spindle Head for milling the Valve Disks

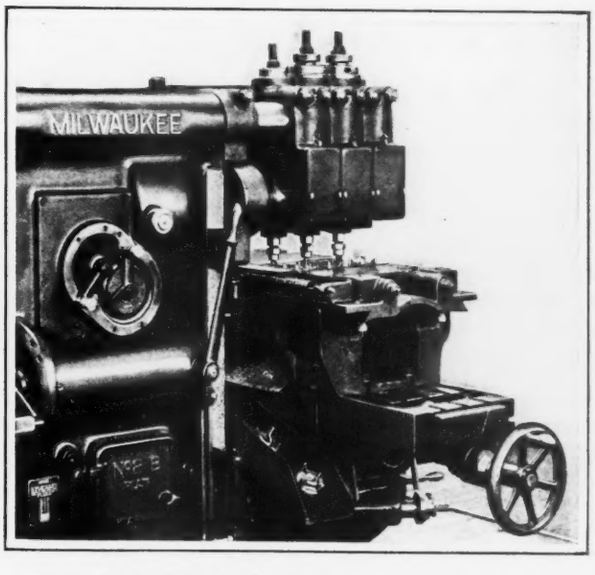


Fig. 3. Another View showing the Arrangement of the Trough for delivering the Valve Disks into a Tote Box

Do's and Don'ts for Oxy-acetylene Welding

By A. EYLES

AUTOGENOUS welding has long since passed the experimental stage, and has become a permanent and important factor in the manufacture and repair of machinery and metal products. It makes possible strong welded joints, and provides a means of increasing production and, in many instances, greatly improving the quality of a product. Wherever trouble or failure is experienced with oxy-acetylene welds, it is safe to say that it is due to the employment of unsuitable or incorrect methods or a lack of knowledge of the characteristics of the materials used.

Skill and training, as well as a knowledge of the theories of oxy-acetylene welding, are necessary in order to attain proficiency in the art of autogenous welding. The following "do's" and "don'ts" are based on the writer's knowledge of autogenous welding gained during twenty years' foremanship in a plant which required considerable supervision of this kind of work. The information here presented is intended to be of assistance in developing correct methods and in overcoming the usual defects encountered in learning to produce efficient welds.

Requirements for Welding

The following points should be given careful consideration before commencing a welding job; otherwise considerable delay or a defective weld may result.

Before commencing the welding operation, make sure that the available supply of acetylene and oxygen is sufficient to complete the weld.

Be sure that the gases are pure, and the welding materials adapted to the work, particularly when the material to be welded is aluminum or copper.

Make certain that the torch is in good condition, and that the acetylene and oxygen pipe lines are sound and securely attached to their respective supply tanks.

Be sure that the regulator on the oxygen cylinder is in good working order and will pass the required amount of gas without fluctuations.

Wear suitable goggles, to protect the eyes not only from the intense light, but also from the fine slag-like substances that are formed during the welding operation. It is also desirable to provide a suitable protection of some kind for the clothing.

Don't stop or delay the welding operation when it is only partly completed, as this will result in a defective joint.

Precautions in Handling Welding Equipment

Keep a bucket or other suitable receptacle filled with water in a convenient position for cooling the torch or for use in case of fire.

If the valves become frozen, thaw them out by applying hot water; do not apply a flame or hot metal bars to the valves or any part of the equipment.

Always keep the torch in good condition, and hang it up carefully when the job is completed.

Don't allow oxygen or acetylene cylinders or tanks to be exposed to the heat from stoves, furnaces, or radiators, or to the direct rays of the sun, as an increase in the temperature of the gas will cause a corresponding increase in the pressure within the cylinder. Any excess heat may also soften the safety plug or disk with which the cylinder is provided, causing it to blow out and permit the gas to escape.

Don't leave the torch burning unless it is actually in use; matches are less expensive than acetylene and oxygen.

Don't use oil or any greasy substance on oxygen valves or connections, as its contact with oxygen under pressure is likely to cause combustion. If a lubricant must be used, the purest glycerine obtainable should be employed.

Don't use an open flame for the purpose of locating leaks in acetylene equipment. Leaks can generally be detected by the odor of the acetylene gas, and their exact location can be determined by applying soapy water to the surface of the receptacle, watching for the appearance of soapy bubbles formed by the escaping gas.

Don't use a steel tool of any kind to clear or clean the holes in the torch nozzle, as this practice is likely to damage the torch. With care, however, copper wire may be used for this purpose. The dimensions of the openings in the torch nozzle must not be changed.

Don't forget that the fumes of zinc oxide given off during the welding of brass are injurious. Large quantities of milk serve as a very good antidote.

Lighting the Torch

Exercise care in lighting and shutting off the torch. To ignite or light a torch, first turn on the acetylene and ignite the gas. Next open the acetylene valve until a bluish flame with a small cone or bulb appears. This is a neutral flame. When a carbonizing flame is required, it can be obtained by using an excess amount of acetylene.

Pay careful attention to the pressure at which the oxygen is used, as the question of economy and the quality of the weld are intimately connected with this factor.

Don't ever direct the flame from the torch toward anyone, because the sparks may seriously injure the eyes.

Selection of Torch Tip

The correct size of torch tip is determined by the thickness of the metal to be welded and the rate at which the heat is dispersed. If the tip is too small, such defects as adhesion, the formation of oxide, overheating, and burning of the metal result. On the other hand, a tip that is too large produces a molten bath much larger than is necessary, and holes and adhesion in the lower part of the weld occur.

The oxy-acetylene torch flame can be readily employed to weld sheet metal 1/64 inch thick or boiler plate having a thickness of 1 1/2 inches.

Oxy-acetylene torches with interchangeable tips are generally preferable for repair work, while the fixed power torch has advantages in repetition work.

A good weld can be obtained only when the torch will constantly maintain a neutral flame. Therefore the torch should be designed and constructed in such a manner that the oxygen and acetylene will be delivered at constant pressures and in constant volumes. In other words, a torch that will not maintain a neutral flame under all operating conditions cannot be expected to produce sound welds.

Preventing Back-fire

Keep the head and joints of the torch tight in order to prevent back-firing. When a torch back-fires, shut off the oxygen valve first, and then close the acetylene valves. Next place just the tip of the torch in water, and when this has become cool, the head may be completely immersed.

Don't allow the tip of the torch to come in contact with molten metal, as this will clog the holes and cause the torch to back-fire.

Cleaning and Preheating Work

Thoroughly clean the surface and edges of the material where the welding is to be done; otherwise, impurities in the metal may set up disintegration in the welded joint, which may ultimately cause it to fail. Impurities may also make the material porous and spongy, owing to the liberation of gases during the welding operation. Again, pieces

of foreign matter may prevent the molten metal from filling all parts of the weld and may cause cavities or blow-holes.

When repairing broken machinery by welding, one of the prime essentials is to prepare the broken part properly before commencing the weld. The chief consideration in this respect is the factor of expansion and contraction. As nearly every job presents different conditions in this respect, the operator must carefully consider each individual problem, and make use of the knowledge gained through past experience in devising means to prevent undue strains from developing in any part of the work.

It is generally possible to eliminate serious strains in the work by careful preheating.

It is advisable to preheat thick parts, especially if they are castings, before attempting to perform the welding operation.

Remember that it is much better to produce expansion by preheating before welding than to attempt to relieve the strains caused by contraction after the weld has been completed.

Bear in mind that the expansion and contraction of the welded pieces cannot be controlled or arrested mechanically. If the pieces can expand in all directions, very little or no trouble will be experienced from strains.

Remember that the effects of contraction produced by the cooling of the welded part demand as much consideration as the effects of expansion. In other words, contraction is as likely to produce warping, cracking, or failure as is expansion.

Don't forget, when welding sheet metal, that the effects of expansion and contraction can be provided or compensated for by arranging the edges of the metal at an angle, by "tacking," or by the use of jigs or fixtures to hold the pieces.

Lining up Work

Line up the parts that are to be welded properly before igniting the torch. It is usually necessary to bevel the edges of materials over 1/8 inch in thickness. The beveling should be carefully done, and should extend the full depth of the work, as partial beveling usually results in defective welds. In preparing the welds on sheets or plates from 1/8 to 1/4 inch in thickness, the width of the bevel should be made slightly less than the diameter of the welding rod, in order to insure the filling of the bevel by the molten rod.

When two ends of a metal piece are to be welded to another part, it is necessary to preheat the work in order to maintain alignment; but when only one end is to be welded, this is not required.

Whenever possible, employ jigs or fixtures for repetition work, and in some cases it will prove profitable to employ a jig for a single repair job.

Welding Sheet Metal

The welding of very thin sheets can be facilitated by turning over the edges of the sheets to an angle of 90 degrees. The application of the welding flame to both flanges simultaneously serves to fuse one flange with the other, thus effectively joining the two sheets.

Vary the distance of the torch tip from the work according to the thickness and kind of metal being welded. For aluminum, the distance of the tip from the metal should be from 1/4 to 3/4 inch; for brass or copper, from 3/16 to 3/8 inch; and for iron or steel, from 1/16 to 1/8 inch.

Exercise care in selecting a tip of the correct size for the work to be done.

Remember that copper and aluminum are first-class conductors of heat, and consequently, more heat is required than for metals of the same thickness that are poor conductors. For instance, in welding 1/8-inch copper or aluminum, it is necessary to use a torch capable of welding 3/16-inch iron or steel.

When welding sheet metal less than 1/8 inch in thickness, direct the torch flame on the material at an angle of from 45 to 50 degrees instead of at right angles to the work.

To prevent undue expansion or distortion of the metal, use heat conducting blocks or sheets—preferably of copper—on each side of the joint.

Bear in mind that the fusion of the welding metal is not brought about by the point of the torch flame alone, but by the heat of the whole flame.

Remember that a torch flame suitable for welding will not penetrate and produce perfect fusion beyond a depth of 1/8 inch.

Don't use an unduly large amount of heat when welding thin sheet metal. Light weight material that is overheated will show a tendency to buckle as the sheet cools.

Filling-in or Welding Material

In welding copper, it is generally better to first raise the whole mass of the metal to a moderate temperature, and then employ a small tip for the actual welding operation, rather than to employ a large size tip on the cold metal.

Remember that the harmful effect of oxygen, in welding copper, can be overcome by a careful regulation of the gases in the torch flame, and by the use of a very pure copper welding rod that is free from oxide.

Be sure that filling-in material of practically the same chemical composition as the work to be welded is employed.

Bear in mind that the first essential of all filling-in materials is purity, because even traces of impurities, under the torch flame, will produce defective welds. In fact, the presence of foreign material in the filling-in metal is probably the chief cause of failure in welded joints.

Flux for Aluminum Welding

It is important to remember that only by employing a suitable flux that will cause the oxide to dissolve at the temperature at which the aluminum becomes molten, can a perfect weld be obtained. The most satisfactory welding flux for aluminum and aluminum alloys seems to be one consisting of a mixture of potassium chloride, lithium chloride, sodium chloride, and potassium bisulphate, which has a melting point of 1112 degrees F.

Don't be discouraged if you have successfully welded iron and steel, but have failed when attempting to weld aluminum, as a different procedure is required for this metal. With experience and a thorough knowledge of the characteristics of aluminum, it will be found one of the easiest metals to weld by means of the oxy-acetylene torch.

Welding Rod for Aluminum

Use a welding rod of suitable dimensions when welding aluminum. For aluminum from 1/16 to 1/4 inch in thickness, it is desirable to use a rod having a diameter approximately equal to the thickness of the metal. Aluminum welding rods over 5/16 inch in diameter are seldom used.

Bear in mind that the melting point of the oxide of aluminum is not only much higher than that of the metal, but is also heavier than the molten metal.

Don't use pure aluminum for filling-in material in welding aluminum alloys, as the pure metal does not give a perfect weld. Pure aluminum is more flexible but softer than the rest of the material, and lacks strength.

Size of Torch Tip

In welding aluminum, it is essential that a torch tip of the proper size be employed. A torch consuming 1.76 cubic feet, or even as little as 0.888 cubic feet, of acetylene per hour can be satisfactorily employed on sheets 1/16 inch in thickness, whereas aluminum sheets 1/4 inch thick require a torch consuming from 24.7 to 28.2 cubic feet per hour.

Don't allow cavities or hollows to form in the line of welding, as they diminish the strength of the weld considerably. A good fusion weld will seldom break in the line of welding.

Welding Galvanized and Other Coated Metals

Galvanized, lead-coated, terne and tinned steel sheets and plates can be welded, but in order to obtain welds that are free from alloys, the coating of the metal must be eliminated from the surface to be welded.

In welding mild steel, very little oxide formation occurs, provided the torch is properly regulated. Consequently fluxes are not generally used for this material, although they may be obtained in the market. The composition of the welding rod, however, must be as nearly as possible the same as that of the material being welded.

Application of Fluxes

A good flux for use in welding copper is a mixture of sodium borate, boric acid, sodium chloride, and a small amount of phosphorus which serves as a deoxidizer. The same flux may be used for brass except that the phosphorus is replaced by aluminum, which reduces the loss of zinc by volatilization and also tends to prevent oxidation of the metal.

Don't throw the flux on the work. It may be added from the welding rod by first heating the rod and then dipping it into the flux, which will fuse or melt and form a coating over the rod. The flux will then flow ahead of the torch flame and thus prepare the metal for welding. The end of the rod and the metal within the welding area should be kept well covered with flux during the actual welding operation.

Don't allow welding fluxes to be exposed to the atmosphere for any length of time, as they absorb moisture rapidly. This causes them to deteriorate, and it is therefore preferable that they be kept in air-tight containers.

Strength of Weld

Care must be exercised in welding copper, as this material offers very little resistance to blows when near the welding temperature. A copper joint or weld is improved, however, by hammering and annealing after the welding operation has been performed.

It is well to remember that the metal immediately surrounding the break in a copper pipe is likely to be structurally weak. For this reason, it is best to remove the metal for a short distance each side of the fracture, and weld in a patch cut from copper plate of the same thickness as the walls of the pipe.

Don't forget that the burning of copper is detrimental to its physical properties. Burning not only reduces its strength to a minimum, but also causes it to become rough, brittle, and practically unworkable.

The metal in a weld cannot be made as good as that of the original material. This is impossible, because the finest grain and the best physical qualities can only be obtained by employing both heat and mechanical treatment. Experience has shown, however, that welds in sheet metal and plates up to 3/16 inch in thickness are from 95 to 98 per cent as strong as the material welded. For plates 1 inch in thickness, the weld is approximately 85 per cent as strong as the unwelded metal.

In cases where great strength is essential, the weld should be built up on both sides of the material, in order to compensate for the weaker material in the weld. No weld can be stronger than the filling-in material.

If a weld is defective before heat or other mechanical treatment is applied, such processes will not prove of real value. In other words, an after treatment cannot transform a poor weld into a good one.

Skill in Manipulating Torch

Skillful manipulation of the welding flame is essential at the moment when fusion has proceeded far enough to insure welding. At this point, dexterity is required to prevent the metal from being deformed under the welding flame. The skill of an operator can best be judged by his handling of a torch at this period of the welding process.

A true ripple weld having ripples that are uniform, both in size and spacing, can be made only by an experienced operator. The best examples of this type of weld are found in sheet metal 1/8 inch or less in thickness.

Welding Monel Metal

The procedure in welding monel metal castings follows closely that employed for cast iron, except that no flux is required. Monel metal castings are less brittle than iron castings, but, nevertheless, they are subject to fracture as a result of non-uniform cooling of the different sections.

Salvaging Welding Rod Ends

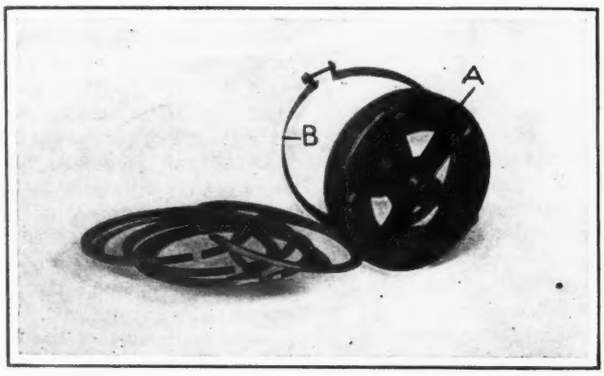
The material in non-ferrous welding rods is often expensive, and for this reason, it is good economy to weld the short ends to new rods, so that all the material can be used up. It is doubtful, however, if it is worth while to weld the short ends of non-ferrous materials to longer rods.

* * *

ARBOR FOR PISTON VALVE RINGS

By J. R. PHELPS
San Bernardino Shops, Atchison, Topeka & Santa Fe Railway

If packing rings for piston valves, or pistons of any kind, are to fit the cylinder properly, they must be finished to size while in a compressed position. The arbor shown in the accompanying illustration is arranged to hold the rings after they have been compressed, and is intended particularly for the rings of locomotive piston valves. The outside diameter of rings of the No. 225 class is 15 7/16 inches before splitting, and the valve chamber diameter is only 15 5/64 inches; hence, after the rings are split and a recess has been made for the dowel-pin that prevents the ring from turning, four rings are placed on the arbor, the side clamping plate *A* being first removed. After this plate has been replaced, but before tightening it, the steel band *B* is clamped around the rings in order to compress them to the working position. Before this band is removed, plate *A* is, of course, tightened. The compressed rings are slightly larger than the valve chamber to provide enough metal for turning them true and to the exact valve chamber size. Rings made in this way will fit perfectly around the entire circumference without filing or hand fitting.

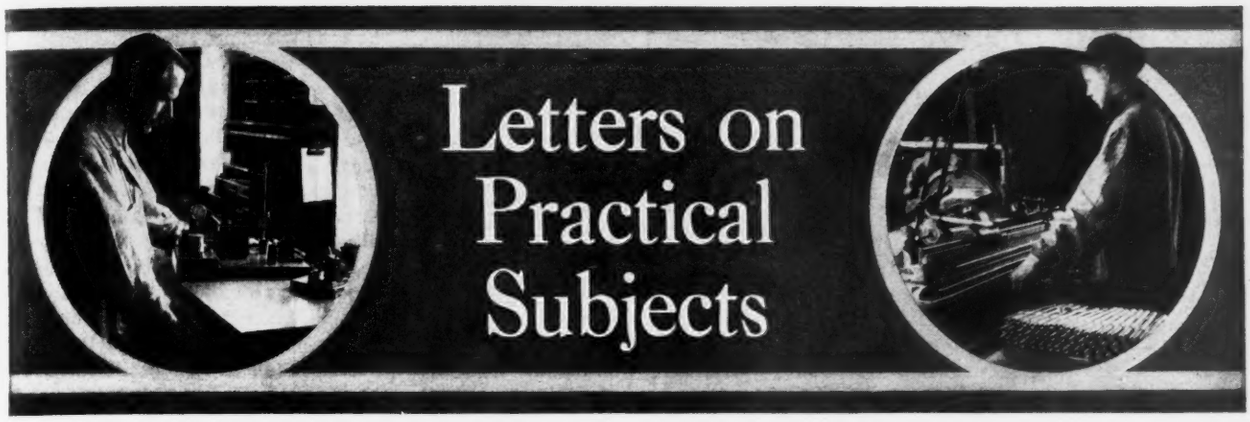


Arbor used for holding Piston Valve Rings in Compressed Position while finishing Outside to fit Valve Chamber

* * *

GERMAN SCREW THREAD STANDARDS

The German national standardizing body recently issued the second edition of its book on screw threads by Professor G. Schlesinger of the Charlottenburg Institute of Technology. It contains several additions due to developments in the standardization work in this field which have taken place in the last three years. This applies particularly to the sections dealing with the designation of screw threads on drawings; special threads as developed by trade sectional committees; and screw thread tolerances. The book deals with the following subjects: fastening threads; fine threads; special threads; trade standards for threads; abbreviated designations for threads; representation of threads on drawings; non-standard threads; screw thread tolerances and screw stock tolerances; and foreign thread standards. Those interested in these standards may consult the book at the office of the American Engineering Standards Committee, 29 W. 39th St., New York City, or they may obtain copies from Normenausschuss der Deutschen Industrie, Ingenieurhaus, Berlin N.W. 7, Germany (price, 4.25 marks, bound in cloth).



AUTOMATIC INDEXING FIXTURE FOR HAND MILLER

The small bevel gear shown at *W* in Fig. 1 is economically produced in large quantities on an ordinary hand miller equipped with the automatic indexing fixture shown in Figs. 1 and 2. The gear teeth are of short length, and while only a single milling cut is taken for each tooth space, with the blank in a central position, the work is held well within the limits of accuracy required.

The details of the fixture are clearly shown in Fig. 1. The body casting *A* is bored to receive the hardened steel spindle *B*, which is machined to receive the draw-in collet and draw-rod extending from the handwheel *D*. Over the rear end of the spindle and next to the index-plate *C* is a rocker plate *E*. This plate carries a pawl *F* which engages the ratchet teeth milled in the side of the index-plate *C* and serves to rotate this member. The rocker also carries the swinging cam *G* which releases the lock-bolt *H*.

The pawl is rotated sufficiently to cause the lock-bolt to be entirely extracted before it rotates the plate. Also, cam *G* moves past the roll in the lock-bolt, but not before sufficient rotation of the plate is accomplished to allow the roll to ride on the spaces between the notches. The continual rotation of the plate allows the lock-bolt to slip in place in the next notch and thus secure plate *C* in position for cutting the next tooth space.

The indexing mechanism is actuated during the backward movement of the miller platen obtained by the hand-lever *Z*, Fig. 2. This movement is positively stopped by the adjustable stop-screw at *I*, Fig. 1, when contact is made with the stop-block *Y*, which is secured to the saddle. Feeding the platen forward and cutting the tooth results in a sufficient movement to permit the cam to be returned to its original position. During this return movement, the bevel edge on the front side of the cam *G* causes the cam to move outward, as shown in Fig. 2, so that it slides over the side of the lock-bolt, leaving it undisturbed. A small coil spring *T* serves to return the cam to its proper position in line with the lock-bolt, ready to extract the bolt on the next indexing movement. The tooth depth is controlled by the stop-screw *K*, Fig. 1. The gear blank is located on the lower side of the cutter-arbor, or below its center. Two threaded thrust nuts provide means of taking up the end thrust on both the rocker and the spindle.

The changing of the longitudinal movement to rotation is described in the following: On the backward movement of the platen the collar *M* is held stationary by the dog which carries screw *I* when the latter strikes the stop-block. The continued backward movement causes the whole fixture to slide along rod *R*. The cam *P*, also sliding backward, with its spiral groove drawn over a roll which projects from the block *O*, results in a rotary movement of the cam. The cam *P* drives the shaft to which the arm *Q* is secured. The arm *Q*, swinging with the cam, operates the rocker block which carries the indexing mechanism.

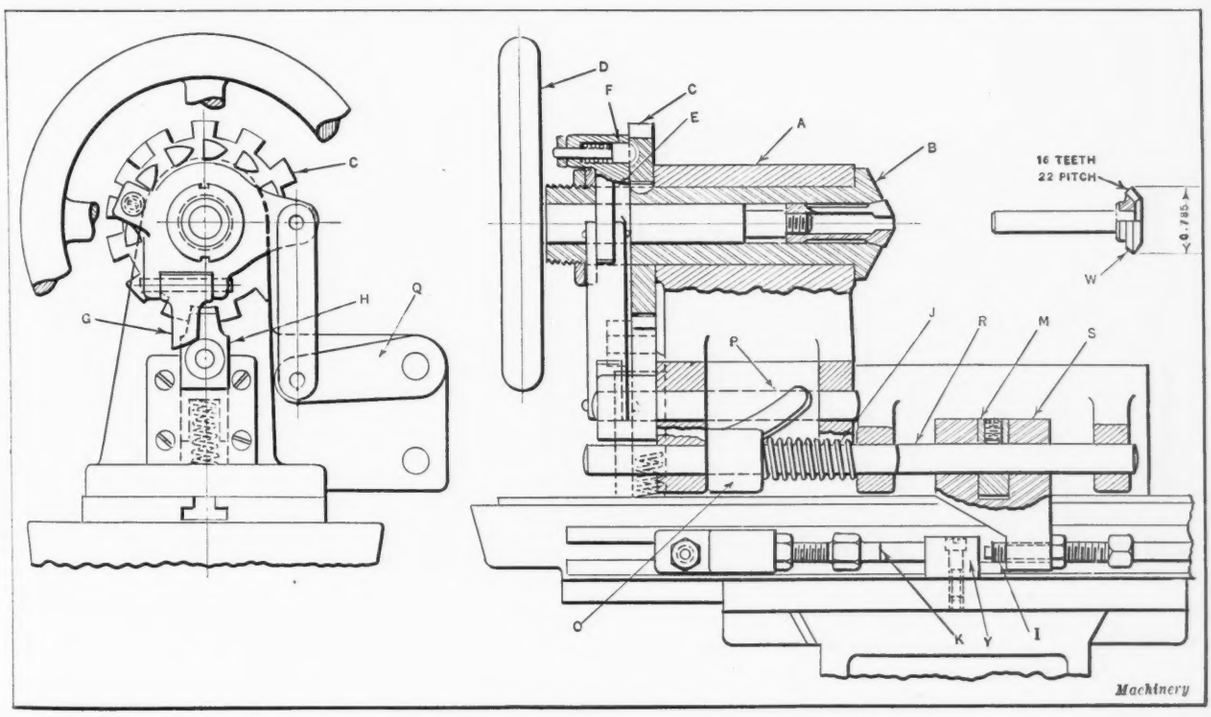


Fig. 1. Details of Automatic Indexing Fixture used on Hand Miller

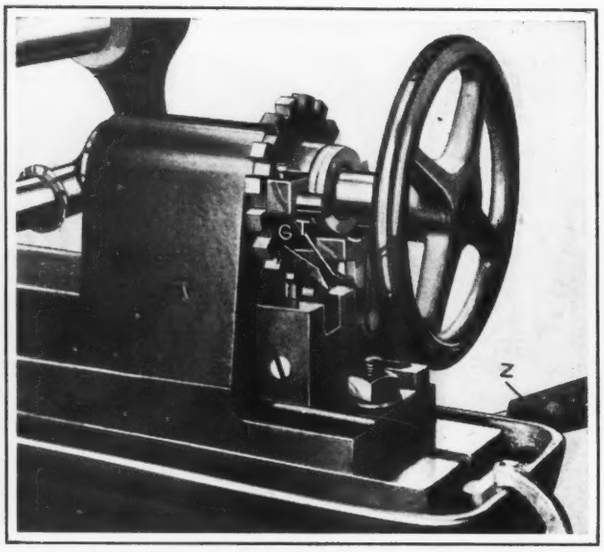


Fig. 2. Automatic Indexing Fixture shown in Fig. 1

The forward movement of the platen releases the dog *S*, and the entire indexing mechanism is returned to its original position through the action of spring *J* which was compressed on the indexing stroke. Dog *S* can be swung out far enough to clear the stop-block, thus permitting the fixture to be used in a convenient position for removing and reloading the work, which is held in the draw-in collet *B*. With the fixture described, the small sixteen-tooth pinions are produced at the rate of one pinion every forty-five seconds. The fixture described can be easily set up, and therefore can be profitably employed on small lots. Different numbers of teeth may be cut by providing index-plates having the required number of notches.

Elkhart, Ind. I. F. YEOMAN

PUNCHING HOLES IN MALLEABLE IRON

The automobile industry has brought about the use of the punch press on a new class of work, namely, the piercing of holes in malleable-iron parts. When the holes are quite large in proportion to the thickness of the stock, they can be produced as accurately by punching on the press as by drilling. However, when the thickness of the stock is nearly equal to the diameter of the punch the accuracy is somewhat impaired.

There are a few points on piercing holes in malleable iron that should be carefully considered, and one of these is the clearance between the punch and die. This clearance should be practically the same as in the case of sheet-steel work, namely, between 5 and 10 per cent of the stock thickness, but the punches are tapered slightly toward the top or, in other words, the cutting end of the punch is smaller than the section immediately above it. For the average job, a taper of about 0.003 or 0.004 inch per inch is sufficient to permit the piece to be readily stripped from the punch.

When setting the tools, they are so adjusted that the end of the punch does not enter the opening in the die, but descends until it is almost in the same plane as the face of the die. This precaution is necessary, as malleable iron does not always shear uniformly, and often the hole breaks through at a slight angle. When this happens, the punch, of course, follows the hole, and in so doing, strikes the edge of the die, resulting in a sheared or broken punch.

Whenever possible, the stripper should be provided with a cam- or screw-actuated clamp which will hold the work securely on the die member. When the stock thickness is nearly equal to the diameter of the hole, and particularly when the upper face of the casting is not machined, it is absolutely necessary to have a stripper than can be clamped down on the work. A slight irregularity in the upper surface will cause the casting to be tipped when it is brought up against the stripper plate above the die, and this is likely to break the punch.

The range of hole sizes that can be punched in malleable-iron castings is practically the same as in steel. By back-tapering the punches, holes having a diameter less than the thickness of the metal have been successfully punched. In one case 5/32-inch holes were pierced in 3/16-inch malleable iron with punches having a back taper of 0.012 inch per inch. Such practice cannot be carried out, however, when the holes are close to the edge of the casting, as the excessive taper on the punch might cause the work to crack.

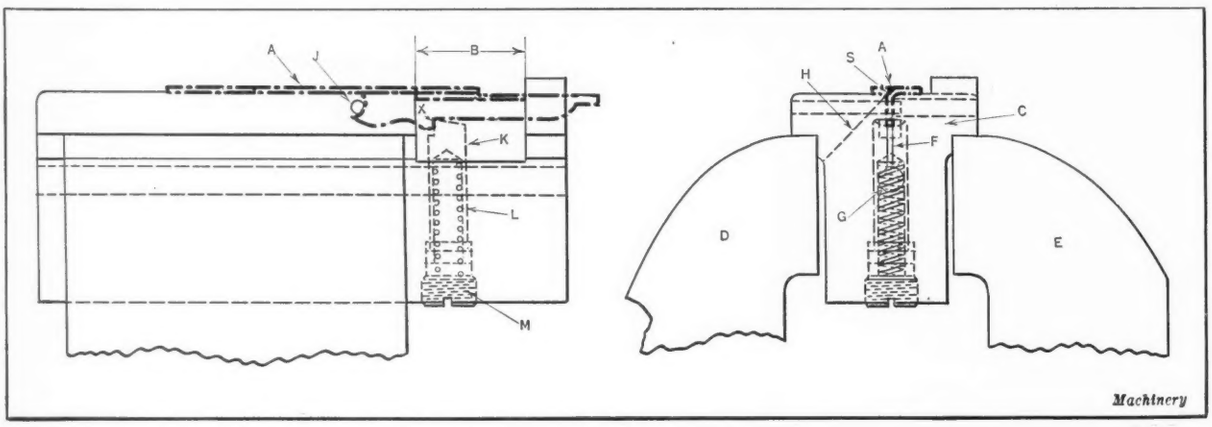
It is a safe practice to have the distance between the edge of the hole and the edge of the work equal to the diameter of the hole, in the case of round holes, or to the distance across flats, in the case of rectangular holes. By employing well-made tools and exercising care, it is possible to punch holes much closer to the edge of the work, and, in some cases, in fact, the distance from the edge of the hole to the edge of the piece is not more than the thickness of the stock.

Cleveland, Ohio EDWARD HELLER

BENCH VISE FIXTURE FOR FILING BEVEL

The special bench vise fixture shown in the accompanying illustration was designed to facilitate the accurate filing of a slight bevel on the work *A* for a distance indicated by dimension *B*. The block *C* is mounted in the bench vise, the jaws of which are shown at *D* and *E*. The block is slotted at *F* to receive the work. The combination of the drilled hole *G* and the slot gives the jaws a slight spring action, which permits them to grip the work securely when the vise jaws *D* and *E* are closed.

After the work has been clamped in place, the bevel *S* is filed, the file being guided by the hardened surface *H*, thus insuring the correct bevel. The pin *J* and the spring pin *K* are employed to locate the work. The spring pin *K*



Fixture which serves as Guide for filing Bevel

is placed in the fixture from the under side of the block, following which the spring *L* is put in position and backed up by the short screw *M*.

The work is placed in position agains the pin *J*, with the corner *X* against the flat on the spring pin *K*. The spring pin is depressed when the work is pressed down into position so that the corner *X* will snap back into place. The work is then held down firmly against the top of the block *C* while the vise jaws are tightened on the fixture. Two or three passes of the file are sufficient to produce the required bevel at *S*, after which the vise is opened slightly. The spring pin *K* then raises the work so that it can be easily removed from the vise. H. M.

USING A RADIAL DRILL FOR LOCATING HOLES

The method of locating holes in cast-iron boxes here described gave satisfactory results and saved the expense of building a drill jig. The castings were of a box shape and were required to have four evenly spaced holes, drilled in a line, through the bottom of the inverted casting. These holes were also required to be tapped with a 3/4-inch pipe tap.

The table of the radial drill was provided with blocks to insure locating and clamping each casting in the same position, with the center line of the holes coinciding with the radial line of travel of the drill spindle along the radial arm. The spacing of the holes was accomplished by means of pieces of 1/2-inch square cold-rolled stock cut to the proper lengths, the difference in length between each succeeding rod being equal to the distance between the centers of the holes drilled.

A parallel clamp secured to the top of the radial arm served as a stop for one end of the locating rod. After placing one of the rods in position, the drilling head is fed outward along the radial arm until it is in contact with the end of the spacing rod. The first hole is then drilled, the work being properly located under the drill. The same procedure is used in drilling the remaining holes, employing the next shorter locating rod each time to position the drilling head.

Philadelphia, Pa. CHARLES KUGLER

PIERCING, BENDING AND CUTTING-OFF DIE

The die shown in Figs. 1 and 2 is employed for producing pieces like the one shown at *W*, Fig. 2. The first stage in the development of the piece from bronze strip stock, 0.30 inch thick and 9/32 inch wide, is indicated at *Y*, Fig. 2. The die is provided with a bending block *A*, Fig. 1, in which the piercing bushing *B* is inserted. This bushing can be removed for grinding or renewal, as required. The die member consists of the bending die *A*, the piercing die *B*, the cutting-off die *D*, and the final bending die *E*, which is equipped with the pressure pad *F*. The pressure pad is backed up by a spring *G*. The stop or gage *H* serves to locate the piece for the final bending operation. All the tools in the die member, as well as those in the punch member, are of hardened tool steel.

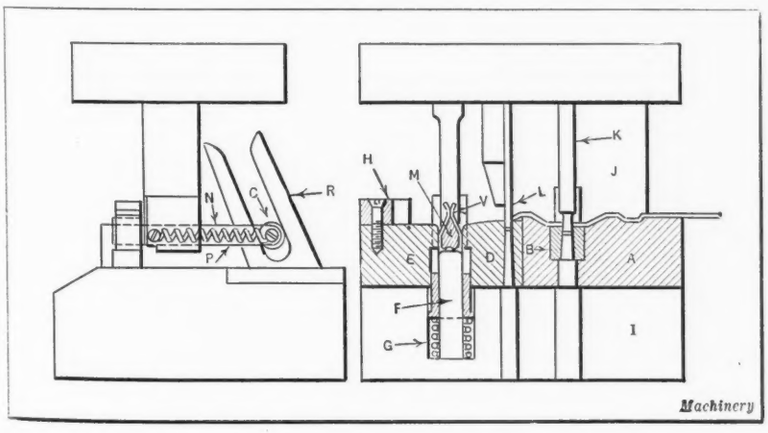


Fig. 1. Die for producing Part shown at W, Fig. 2

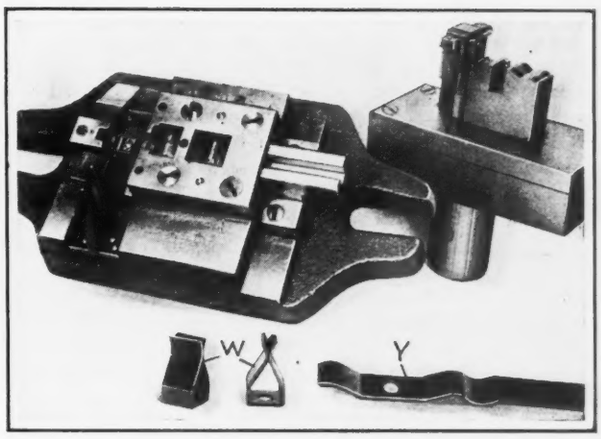


Fig. 2. Punch and Die disassembled

The punch member consists of the bending punch *J*, piercing punch *K*, the parting blade *L*, and the final bending punch *M*. On the bending punch *M* is located the ejector *N*, which is made up of two flat bars having a roller *C* at the outer ends. As the press ram descends, the ejector is withdrawn or carried to the right by the action of the cam *R*. On the upward stroke, the cam *R* causes the ejector to slide to the left and force the formed piece from the punch *M*. Following this, one piece is finished by each down stroke of the press ram. In order to have the upper ends of the piece closed in properly at *V*, Fig. 1, the pad *F* and the bending punch *M* are machined at a radius which forms the part slightly at this point. This slight forming of the part causes the ends to spring together after the piece has been ejected from the punch or when the assembly screw is tightened down on the formed portion.

Ambridge, Pa. JOHN STRAMA

MULTIPLE-SPINDLE CORNER-ROUNDING DEVICE

Some work was recently undertaken at our plant, which involved the machining of a large quantity of pieces like the one shown at *W* in the illustration. As indicated, the four corners of the piece were required to be rounded to a radius of 1/8 inch for a depth of 7/16 inch. At first, the rounding of the corners was done on a grinding machine equipped with a hard grinding wheel. As the work was held in the hands without any guiding means, the corners produced were not uniform, and as a result, many of the pieces were rejected by the customer. It therefore became necessary to employ a more accurate method of rounding the corners. Finally, the milling head shown in the illustration was designed. This attachment was secured to the spindle of a drilling machine. After milling the corners with this attachment, it was only necessary to remove the burrs and smooth up the rounded surfaces with a bull-neck leather polishing wheel.

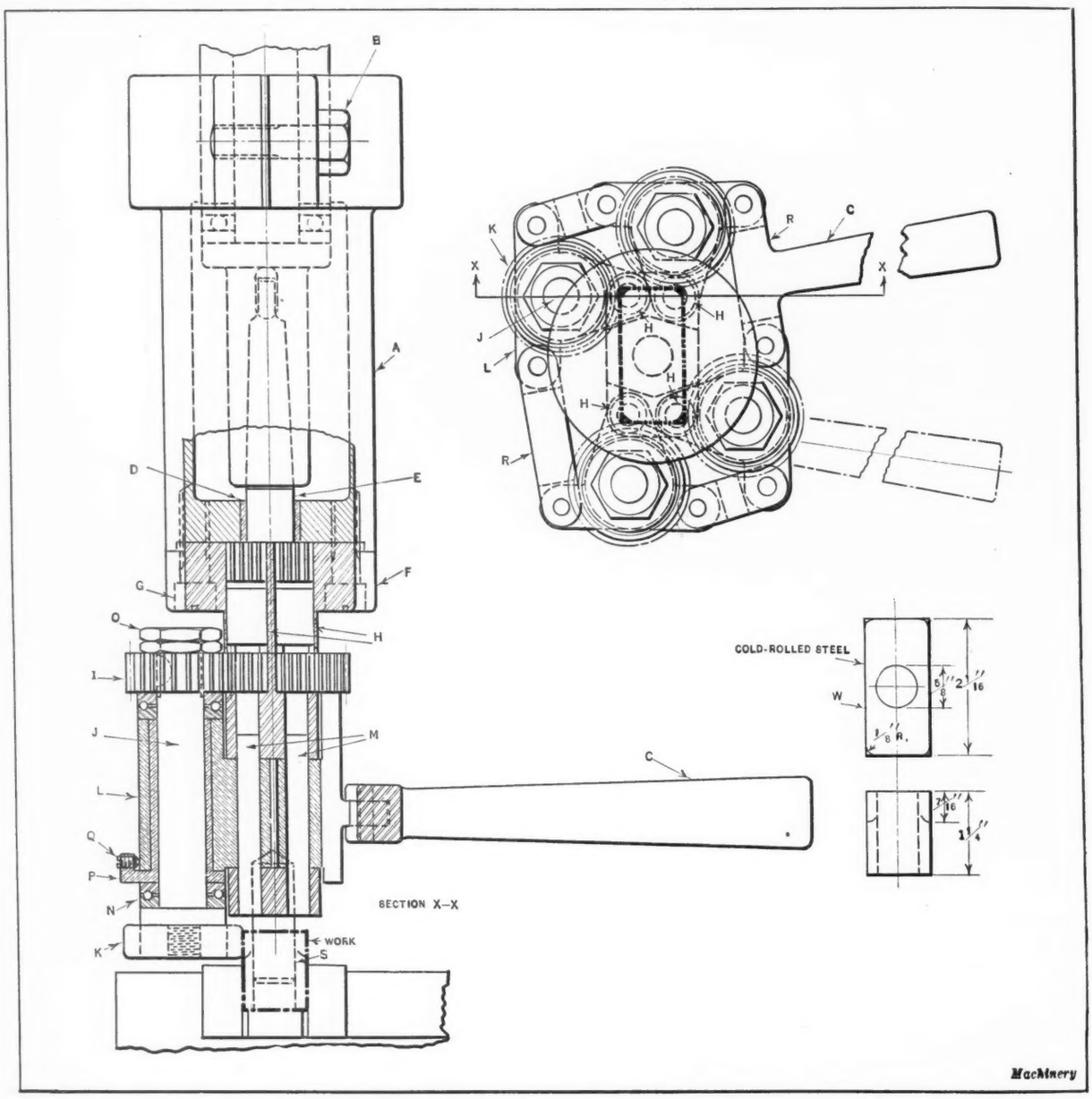
The milling head is patterned somewhat along the lines of the ordinary multiple-spindle drilling head. It is supported on the drill-press quill by the shell *A* which is clamped in place by screw *B*. The bearings for the milling cutter spindles are so pivoted and connected by a toggle lever arrangement that the four corners of the work are rounded simultaneously when the lever *C* is swung through an arc of approximately 25 degrees.

In the lower end of shell *A* is a bronze bushing *D*, which forms a bearing for the driving gear cut integral with the driving shaft and the shank *E*. The lower end of the shell is also recessed to receive the lower part of the milling head *F*, which is secured in place by screws *G*. The four pinions *H* are located in line with the centers of the radii to which the corners of the work are to be rounded. Each pinion extends downward and meshes with a gear *I* on the upper end of the cutter-spindle *J* on which is mounted a cutter *K*. The cutter-spindle is carried in a swinging member *L*, which is pivoted on pin *M*. The center of each pin *M* is in line with the center of the pinion *H* directly above it. The thrust of the cutter is taken by the ball thrust bearing *N*, and adjustment for wear is provided by threading the upper end of the cutter-spindle and using lock-nuts *O* to secure the spindle when it is properly adjusted.

The formed type of cutter employed is threaded to fit the spindle, and is sharpened by grinding on the face of the teeth only. This type of cutter was selected because its diameter is not reduced so rapidly by grinding. Adjustment for wear of the cutters is provided for by the eccentric bushings *P* in which the cutter-spindles run. The eccentric bushings are held in place by the set-screws *Q*. When the cutters are new, the tool is so adjusted that the teeth of the gears and pinions are partly out of mesh. When the cutter is ground, the bushings may be moved inward to compensate for the smaller diameter of the cutter. Care is taken, of course, to see that all the cutters are of the same diameter and that all the bushings are set in the same relative positions.

The four swinging members *L* are connected by links *R*, one of which is integral with the operating handle *C*, which is shown in position at the end of the cutting or machining movement. As the work had a 5/8-inch hole in its center, a pilot pin *S* was provided for the lower end of the milling head to insure proper alignment of the work with respect to the milling cutters.

C. A. K.



Device which rounds Four Corners of a Block simultaneously

METHOD OF DEVELOPING CAM PROFILE

The principal curves used in cam design are the helical, elliptical, parabolical, and the arc and tangent curves. Cams having curves developed by the latter method give an uneven motion at the beginning and at the end of the stroke; the helical curves give a fairly smooth motion at medium speeds; and the parabola gives an easy rise and has a medium pressure angle. The method of laying out parabolical curves will be described in this article. In a cam milling machine, the work is mounted on a mandrel and is advanced toward the cutter while it revolves through a given angle.

DATA USED IN DEVELOPING CAM PROFILE

N	D	S	F
1	1	1	0.003
2	3	4	0.012
3	5	9	0.027
4	7	16	0.048
5	9	25	0.075
6	11	36	0.108
7	13	49	0.147
8	15	64	0.192
9	17	81	0.243
10	19	100	0.300
11	21	121	0.363
12	23	144	0.432
13	25	169	0.507
14	27	196	0.588

Machinery

The cutter used in milling the cam should be of the same diameter as the roller that is to be actuated by the cam. Referring to the illustration, the working angle is 84 degrees and the throw 1.176 inches.

Half of the working angle and the throw of the cam are the only dimensions or specifications to be considered in developing the parabolical curve, as it is symmetrical on both sides of the lines that represent the maximum and minimum diameters. Taking 3 degrees as the angle increment, we have 84 ÷ 3 = 28 spaces. Now 1.176 ÷ 2 = 0.588, which is the radial increment at the middle or fourteenth radial line.

The problem now is to divide 0.588 into 14 parts which are proportional to the arithmetical progression 1, 3, 5, and so on up to 27. These figures are set down as shown in the accompanying table. In column *N* is given the number of the term, in column *D* the series numbers, in column *S* the sum of the consecutive terms, and in column *F*, the value of the increments found by multiplying the numbers in column *S* by the first increment, which is the quotient of one-half the amount of rise divided by the total sum of the series in column *S*. The mathematical calculations may be greatly facilitated by the use of logarithms. The increments on the opposite side of the curve are found by subtracting the numbers in column *F* from the total throw, taking 0.003 from 1.176, 0.012 from 1.176 and so on.

Baltimore, Md. HENRY R. BOWMAN

FILING TECHNICAL MAGAZINES

Many who read MACHINERY and other technical magazines may wish to file part or all of the text for future reference. After trying a number of filing methods, the writer finally adopted the plan described in the following: First, the clips are removed and the pages to be filed for reference are placed together; then the original wire clips are shortened and bent over to hold the pages in place. After the material has been removed from each magazine, it is placed in manila paper folders, such as are used for filing letters. A good grade of folders should be used. The text from three magazines can be conveniently filed in one folder. The front part of the folder is folded over at *C*, making the width or distance *A* from the original fold, equal to the combined thickness of the three magazines to be bound.

For holding the magazines in the folder, metal clips made by the American Clip Co. are used. This clip is made in two parts, the ends of one part going through holes punched through the folder and the magazines and engaging slots in the other half of the clip. The ends are then bent down and pressed into small projections at the side of the top half. This clip presents a smooth surface on both sides of the folder with no heads or points projecting.

The magazine sheets are usually a little longer than the standard letter-size folder, but by leaving the same amount projecting at each end of the folder, the ends can be sheared

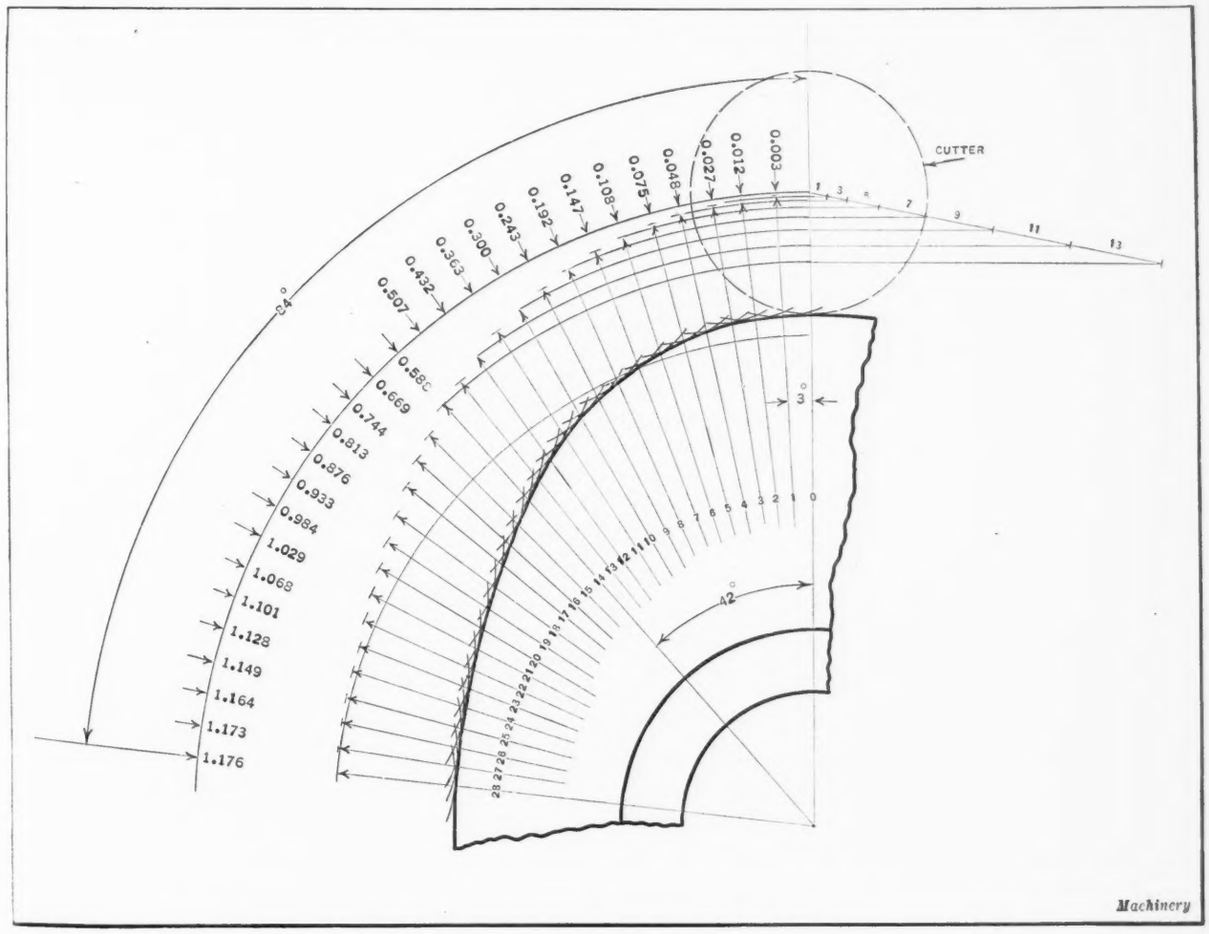
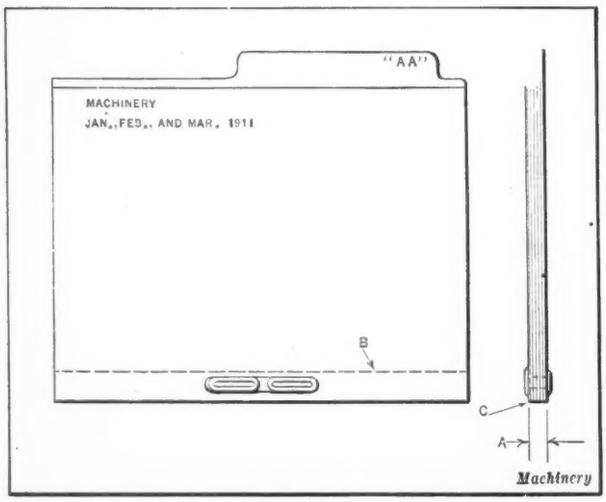


Diagram used in explaining Method of developing Cam Profile



Folder for Technical Magazines

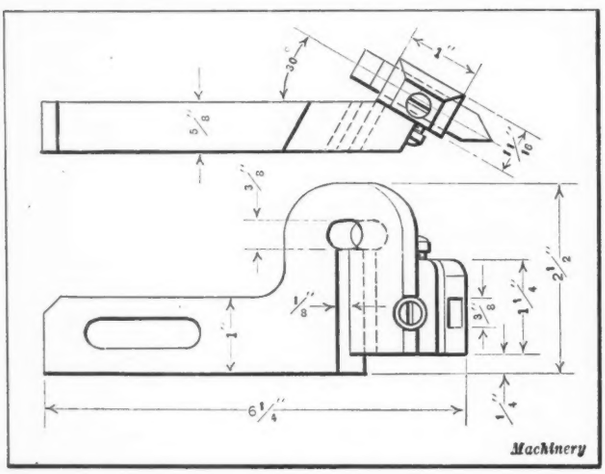
off even with the folder in a paper shear. This operation can be performed by the local printer. After the clips are fastened, a line is scored along the folder at *B*, and the top folded back in order to facilitate examination of the contents. If this is not done, the folder is likely to become broken at some other point.

While the folders can be kept in a bookcase, desk drawers, or any other convenient place, the writer has found that a standard filing cabinet is the most desirable. After the magazines are bound, there will be four folders for each year, each about 3/8 inch thick. In the upper left-hand corner of the folder, the name of the magazine and the month and year of the issues contained in the folder may be written or printed. Each folder may be given a reference letter or number on the tab. A card index is used for locating engineering data contained in the folders.

Lititz, Pa. MONROE M. HUFFORD

OFFSET SPRING TOOL-HOLDER

The spring tool-holder shown in the illustration was designed primarily for use in cutting external threads, but it can be used for cutting off or any other operations for which an offset holder of the spring or gooseneck type is applicable. Particular care was taken in designing the holder to adapt it for cutting threads close up to a shoulder and at the same time secure a uniform relief on both sides of the threading tool. It will be noted that the spring slot in the holder is cut at an angle of 30 degrees with the shank and at an angle of 90 degrees with the center line of the threading tool. Thus, when the tool comes in contact with the work, it springs straight down and back and does not veer to one side or the other, as would be the case if the slot were cut at right angles to the shank.



Spring Tool-holder for threading close to a Shoulder

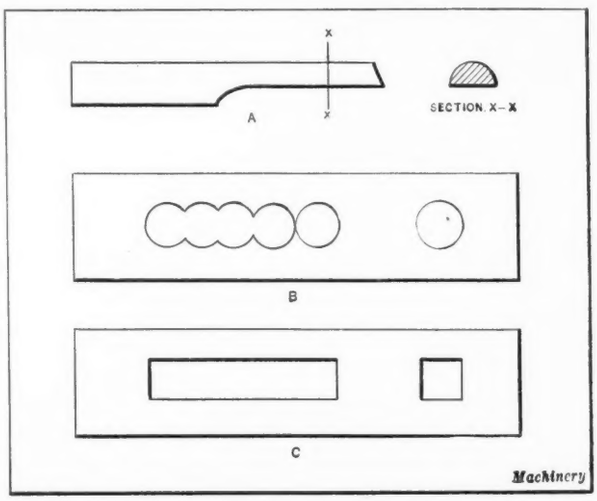
A holder of the type shown can be made any size desired, and the amount of spring can be made to suit requirements by increasing or diminishing the thickness of the material at the top of the gooseneck where the spring action takes place. Spring holders of this design can be used to advantage for parting operations.

Portsmouth, Va. T. J. LEE

TOOL FOR SHAPING SQUARE HOLES

The tool shown at *A* in the accompanying illustration is employed for shaping square holes in tool-bars or any other parts requiring a square hole. The usual procedure in making tool-bars is to drill a hole in the bar and then file out the hole to fit a square tool bit. This method requires considerable time, and can be employed with satisfactory results only by skilled workmen. By using a shaping tool such as here described, the time taken in producing a square hole can be reduced to less than half that required by the hand-filing method.

The tool is made from a piece of drill rod the same size as the drilled hole in the tool-bar. Half of one side of the tool is cut away as shown, either by filing or milling. The bottom end of the tool is ground to a sharp edge and hardened. When the tool is in use, the bar *B* in which the slot is to be cut is clamped to the milling machine table, and the tool *A* placed in the chuck. The tool is set in the center of the drilled hole to be squared, with the flat side



Square Hole Shaping Tool and Work

facing the portion to be shaped first. The machine spindle is then clamped in a fixed position in order to hold the tool as required. With one hand, the operator feeds the carriage back and forth, and with the other hand slowly advances the work to the cutter. After cutting one side of the square hole, the tool is reversed and the opposite side of the hole squared up.

Bronx, N. Y. D. H. SINGER

* * *

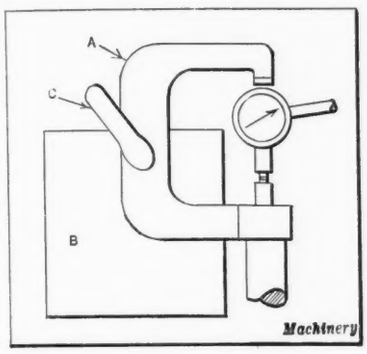
WORLD'S MECHANICAL POWER

In an article by Thomas T. Read, assistant secretary of the American Institute of Mining and Metallurgical Engineers, published in *Mechanical Engineering*, it is pointed out that the total mechanical horsepower produced in the United States exceeds 190,000,000, of which 111,000,000 is produced by coal, 67,000,000 by petroleum, and 12,300,000 by water power. The total mechanical power produced in Great Britain amounts to 45,800,000 horsepower; in Germany, 41,500,000 horsepower; and in France, 17,800,000 horsepower. Canada follows with 10,500,000 horsepower. It has been estimated that the mechanical power produced in the United States per inhabitant is equivalent to the work of thirty-five men working without the aid of mechanical contrivances and power.

Shop and Drafting-room Kinks

CHECKING ACCURACY OF DIAL INDICATOR

The accompanying diagram shows how a 3-inch micrometer can be employed to check the accuracy of a dial indicator. First the micrometer *A* is secured to the face of an angle-iron *B* by means of a clamp *C*, care being taken to see that the spindle of the micrometer is in a vertical position with respect to the surface plate on which the angle-iron rests. The arm that supports the dial indicator is then so adjusted that the contact point of the gage rests on the contact point of the micrometer spindle, as shown in the diagram.



Method of checking Accuracy of Dial Indicator

With this arrangement, the accuracy of the indicator can be checked over its entire range by simply advancing the spindle of the micrometer by steps of 0.001 inch and noting the reading of the dial gage after each advance.

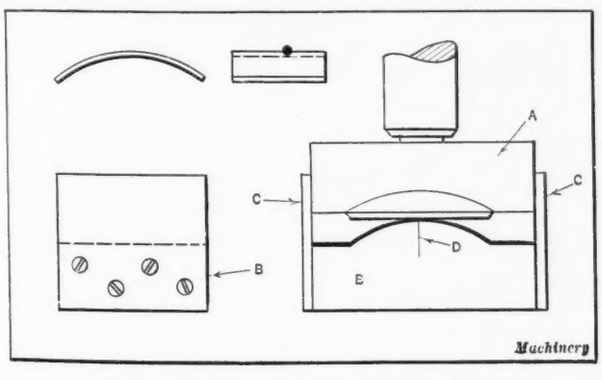
Galion, Ohio — ARTHUR R. MYERS

BENDING DIE MADE FROM WOOD

In experimental work, all sorts of makeshift tools and methods are resorted to by toolmakers and machinists. The wooden forming die shown in the accompanying illustration is a typical example of what can be accomplished in this line. The die shown was made for the purpose of bending a small lot of aluminum gear-case covers to a uniform curve. These covers were to be used on some experimental machines.

The die consists of an upper member *A* and a lower member *B*, with guide strips *C* attached to the bottom half with wood screws. The guide strips are provided for the purpose of locating the punch member *A*. The work is cut to size and a center line is scribed or marked with a pencil near the edge of the blank. When the die is in use, it is placed under the ram of an arbor press. The top member *A* is removed and the blank placed in position on the die, being located centrally by matching the line on the blank with a corresponding line *D* on the front of the die. The punch member is then placed on top of the blank, care being taken not to disturb the blank, after which pressure is applied by the press ram. A piece of flat iron or steel is placed between the ram and the wood member *A*. The use of a temporary die of this kind instead of a forming die of metal saves time and expense.

H. L. WHEELER

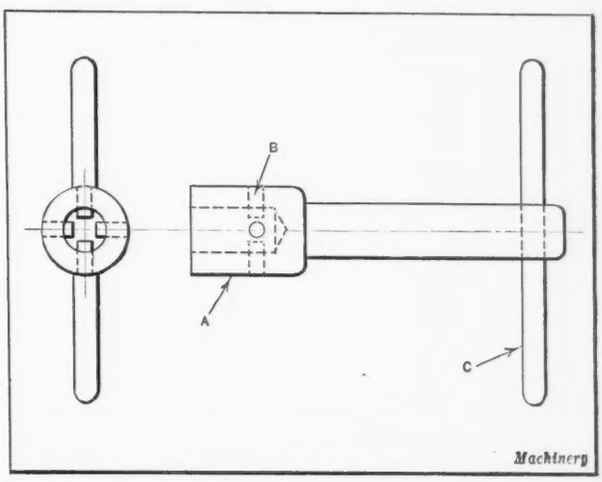


Wooden Die used to bend Sheet Aluminum Pieces

AN INEXPENSIVE TAP WRENCH

An inexpensive yet durable tap wrench which can be readily made in any shop is shown in the accompanying illustration. A piece of round stock *A* is turned down at one end, leaving the other end full size. A hole is drilled or bored in the large end to fit the shank of the tap. The depth of the hole should be equal to the length of the squared end of the tap plus 1/2 inch. Two cross-holes are drilled at right angles to each other to receive the pins *B*. The pins may be driven in or the holes may be tapped and the pins threaded to fit the holes.

The inner ends of the pins should just clear the flats on the squared end of the tap, thus driving the tap. The hole in *A* serves as a guide to keep the tap in alignment with the hole being tapped. The cross-pin *C* is used for a handle. By eliminating the handle *C* and machining a Morse taper on the shank end, the device can be used as a holder for machine tapping. Holders of this design have been used successfully for taps up to 2 inches in diameter. A hole may be drilled and tapped in the side of the holder for a set-screw to keep the tap in place.



Inexpensive Wrench for Taps

Philadelphia, Pa. — F. SELL

GRADUATED STRAIGHTEDGE AND TRIANGLE FOR LAY-OUT WORK

The common drafting operation of spacing off various distances on lines at right angles to a center line may often be done more quickly by using triangles and straightedges having graduated edges. For this purpose, the edge of a celluloid or steel straightedge should be marked off to the required scale, and its border stained in order to accentuate the markings. A similar scale should be laid off on the 60-degree leg of the triangle. The combination of the scaled triangle and straightedge enables the draftsman to quickly draw any required lines or ordinates, or locate points on the drawing.

Brooklyn, N. Y. — DANIEL D. MOLONY

Questions and Answers

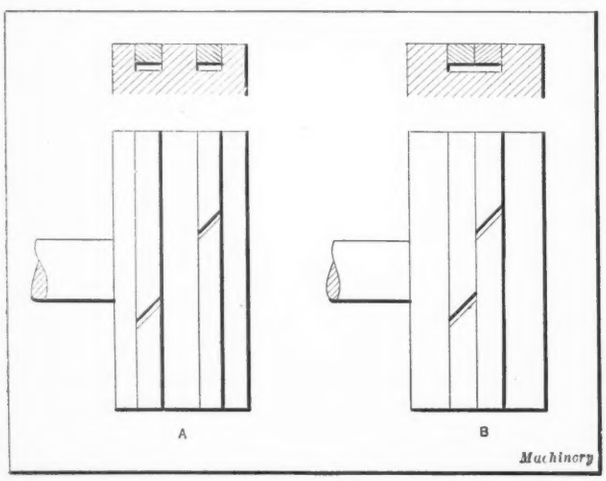
WHY DOES HARDENED STEEL SOMETIMES EXPLODE?

H. V.—A drawing punch, 5 inches in diameter, 9 inches long, and made from 0.90 to 1.05 per cent carbon steel, burst into about six pieces after heat-treatment, the bursting or explosion being accompanied by a loud report. The punch was subjected to the following heat-treatment: It was first placed in an electric furnace having a temperature of 800 degrees F., and was heated to 1450 degrees F., the time for heating being about five hours. Quenching in a bath of salt brine followed, the temperature of the punch being reduced to about 600 or 700 degrees F.; then the punch was placed in an oil bath until cold. Ten days after the heat-treatment described, the explosion occurred. The steel did not show any defects, but it indicated a great amount of strain, and there was a very coarse structure. What caused this excessive strain?

Opinions from any of MACHINERY'S readers regarding the cause of the explosion referred to in the foregoing would be appreciated.

SINGLE AND DOUBLE PISTON-RING GROOVES

D. B. W.—Sketch *A* shows the common type of piston, there being two rings located in separate grooves. Sketch *B* shows a piston that has both rings placed together in a single



(A) Packing Rings in Separate Grooves; (B) Packing Rings in Single Groove

groove. Is the latter form practicable, and has it any advantages?

A.—Although pistons in general have the rings in separate grooves, as at *A*, the single-groove form shown at *B* has been used for certain purposes, and has, we believe, proved very satisfactory. Three advantages are claimed for the single-groove type: In the first place, a single groove may be machined more readily than two separate grooves; second, the wearing surfaces are reduced 25 per cent; and third, the leakage past the rings is said to be reduced.

In regard to the wearing surfaces, it will be noted that piston *A* has four groove surfaces subject to wear and also four surfaces on the sides of the rings, whereas piston *B* has only two groove surfaces and four ring surfaces. Consequently, there are eight sides in contact in the first case, and six in the second, thus giving a 25 per cent reduction.

As to the matter of leakage, when the rings are separated as at *A*, there is an open path between the ring openings (unless this path happens to be sealed by contact between the piston and cylinder, which is not always the case), because the rings are somewhat larger than the piston head. When the rings are placed in direct contact as at *B*, each ring seals the joint of the other one, assuming, of course, that the joints are not directly opposite.

Pistons having a single-ring groove have been used successfully in locomotive air pumps. This type of piston is being used at the Emerson Shops (Rocky Mount, N. C.) of the Atlantic Coast Line Railroad Co., to replace the two-groove type when such replacement is necessary on account of cylinder reboring. (A complete description of this replacement method will be found on page 771 of June MACHINERY.)

The single-groove type of piston has also been used in locomotive fire-door cylinders, for bell ringers, and for certain classes of automobile pistons. Additional information from readers of MACHINERY regarding the advantages or disadvantages of the single-groove piston would be appreciated.

FIT STANDARDIZATION IN OTHER COUNTRIES

A. G. L.—To what extent have tolerances for different classes of fits been standardized in different countries and what, in brief, are the outstanding features of the various systems?

ANSWERED BY JOHN GAILLARD, Mechanical Engineer American Engineering Standards Committee, New York City

National standard systems of fits have so far been established in the United States, Austria, Germany, Great Britain, Holland, Sweden, and Switzerland. All national standards, except the British, are based exclusively on the unilateral system of tolerances. The British standard gives both the unilateral and the bilateral systems, recommending the former. The national standards, with the exception of the American, the British, and the Dutch, give both the basic hole and the basic shaft systems. The United States and Great Britain have adopted the basic hole system, Holland the basic shaft system exclusively. The Dutch system is at one extreme, in affording the maximum freedom of choice in the combination of hole and shaft. It specifies limits only, and does not give allowances or tolerances. The other extreme is formed by the type of system adopted by the Austrians, Germans, Swedes, and Swiss, which gives a number of fits completely defined by their allowances and tolerances. The American system lies between these two extremes.

The standard reference temperature for gages is 20 degrees C., or 68 degrees F., in all the countries mentioned, except Great Britain, where it is 62 degrees F., or 16 2/3 degrees C. Limits for "Go" gages are specified in Austria, Germany, Holland, Sweden, and Switzerland; for "Not Go" gages, in Austria and Germany. (Limits for both "Go" and "Not Go" gages are also to be given in an additional American standard which at present is still in course of preparation.)

The setting up of a national standard system of fits has been started, but not yet concluded in Belgium, Czecho-Slovakia, Italy, Norway, Poland, and Russia.

The August number of MACHINERY will contain an article covering standards that have been established in different countries. This article will be accompanied by a series of diagrams so arranged that a comparison between different national standards may be readily made.

* * *

During the first six months of 1925 France imported 6600 metric tons of machine tools, of which 1864 tons came from the United States, 1962 tons from Germany, 941 tons from Belgium, and 766 tons from Great Britain. During the same period France exported 5050 metric tons of machine tools, Belgium taking 1115 tons, Poland 770 tons, Spain 483 tons, Great Britain 421 tons, Italy 277 tons, and Germany 239 tons.

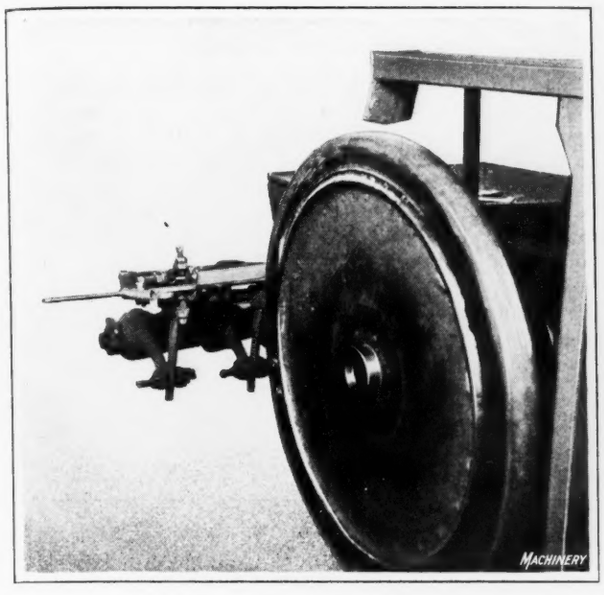


Fig. 1. Semi-automatic Glazing Machine used for finishing Table Knives

Fig. 2. Using a Formed Face Wheel for grinding off the Flash from Silverware

Polishing Table Ware

THE convex surfaces of a table knife require a polishing wheel that is flexible on the face and of the proper density when the work is performed by hand. English cutlery concerns are able to obtain a satisfactory finish without the use of flexible wheels, but that can only be done when the work is performed by experts. In this country, however, the greater part of table knife finishing is done on automatic glazing machines. These machines are provided with a compound movement, so that the wheel follows the surface of the blade instead of depending on the skill of the polisher, as is required when the operation is done by hand.

In the plant of the Oneida Community, Ltd., Oneida, N. Y., table knife blades are forged or rolled from cutlery steel of 0.65 to 0.75 per cent carbon. These blades are first ground on a No. 46 alundum solid grinding wheel, and then the bolster or neck is "cut" or ground on a No. 60 alundum solid wheel. The next step is to grind the blades on the edge by using a leather-covered wood wheel coated with No. 100 alundum, the wheel being set up by rolling in the abrasive. This grinding process is known in the vernacular of the cutlery industry as "candling." The cheaper quality of blades, having a tang at the handle end, are not finished in exactly this manner; after being first ground on a solid alundum wheel, the bolsters or necks are finished on a wheel made of a leather disk with two wooden side plates, so that the leather protrudes beyond the periphery of the side plates. In this way, a narrow leather wheel is formed for finishing the bolsters. The wheel is charged with No. 110 alundum grain.

Knives of the solid type, that is, those having the blade and handle made in one piece, have the flash roughed from the handles with a leather compress wheel set up with a paste-head of No. 46 alundum grain. The handles are finished with a leather-covered wood wheel, 18 inches in diameter and 4 inches wide, coated with No. 100 alundum grain. All the other wheels used in the polishing of bolsters, tangs, and handles, and all the other operations that take place prior to the glazing of the blades, are also performed on wheels 18 inches in diameter, running at a speed of 1800 revolutions per minute.

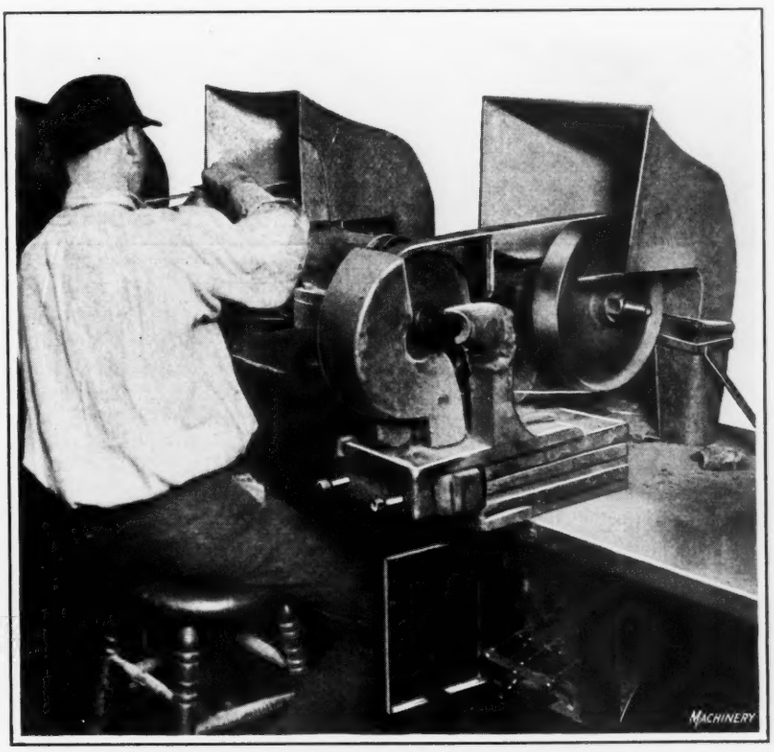


Fig. 3. Machine with Fabric Belt used for polishing between the Tines of Forks

Glazing the Knife Blades

The blades are rough- and finish-glazed on a Hemming type automatic glazing machine, using hard density compress canvas wheels. These wheels are set up for the roughing operation with a paste-head of No. 120 emery, about 3/16 inch thick, and the wheels are dressed with cut cake made of the same grit emery. The finish-glazing operation is done with a wheel set up similarly to that employed for the roughing operation, using No. 150 emery in the paste-head. Fig. 1 shows a view of the glazing machine from the rear; here the recip-

rocating carriage may be seen with a tanged knife blade in place.

The blade is located in a position square with the face of the wheel by means of a screw and check-nut at the tang. A similar screw and check-nut forms a stop at the end of the tang. About fifty reciprocations of the blade-holder are required for each surface, the number of strokes necessary for a satisfactory job being determined for each particular piece of cutlery. The strokes are controlled by a crank movement, and a rocking movement is imparted by means of a spring that can be regulated to suit the conditions.

Higher grade knives of the solid handle type are also glazed in machines of this design, but finer grit abrasives are used on knives of this quality.

Polishing Forks, Spoons, and Other Silverware

The following methods are used for polishing forks, spoons, and other silverware at the factory mentioned. Forks and spoons have their flash removed on a formed face wheel, the operation as performed on spoons being illustrated in Fig. 2. For this work, a leather-covered wood wheel is employed, set up with a paste-head of No. 80 emery, by means of a templet.

The tines of nickel-silver forks made of a composition of 18 per cent nickel, 60 per cent copper, and 22 per cent zinc are polished on fabric belts which are coated with No. 90 alundum grain. The operation known as "fork tining," which consists of polishing between the tines, is also performed on fabric belts coated with No. 90 alundum grain. This operation is illustrated in Fig. 3.

For such work as polishing fruit knife blades made of nickel silver, a solid walrus or felt polishing wheel is used. This operation is known as sand buffing, and the wheel is treated with a mixture of pumice and mineral oil, the oil being used merely to prevent filling the air with dust. These wheels are 6 inches in diameter, and are operated at a surface speed of 7500 feet per minute. After sand-buffing, the fruit knife blades are buffed on loose muslin buffs with tripoli, and are then silver-plated.

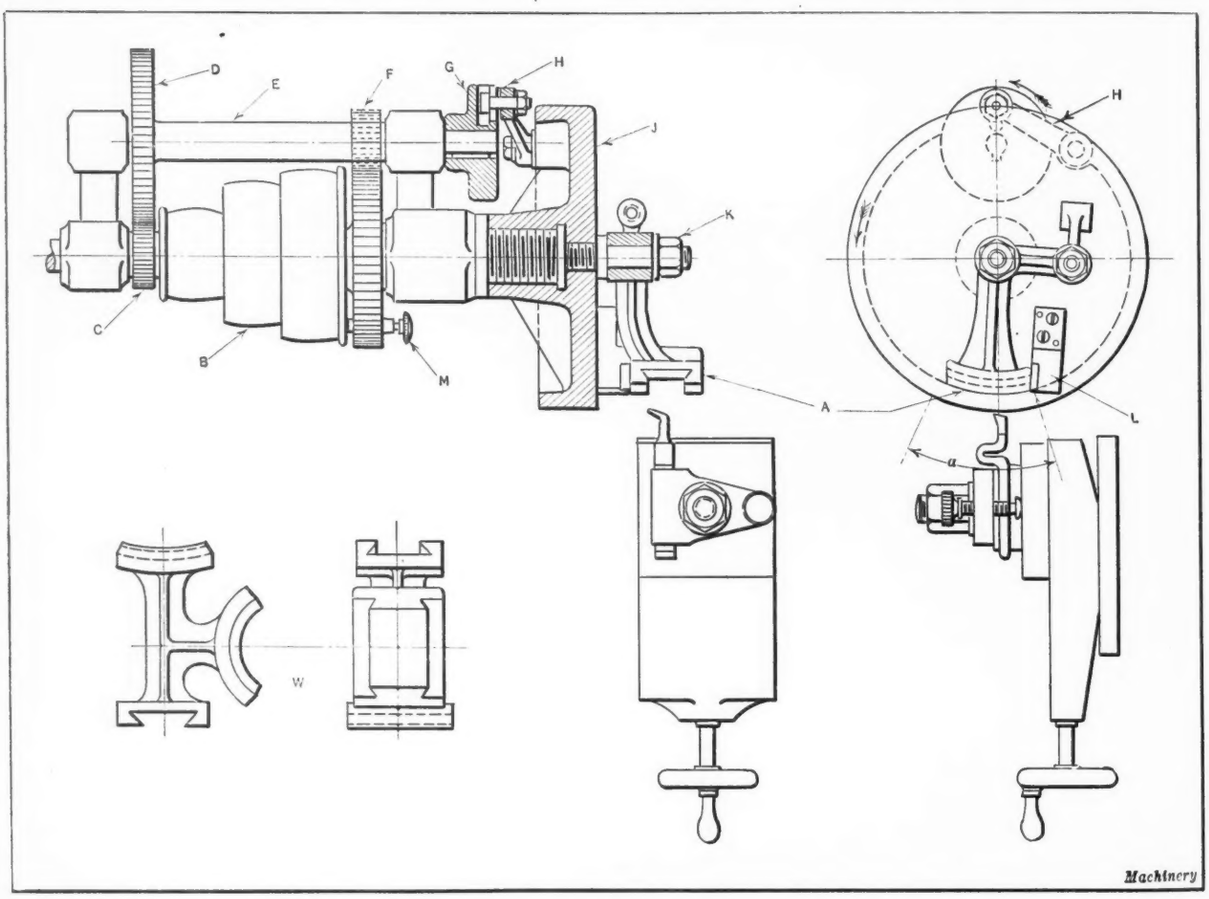
SEGMENT TURNING ON LATHE

By ALEXANDER BARTUSCH

In a shop where there was considerable work that required the turning of segments, a lathe was equipped as shown in the accompanying illustration. With this arrangement, the lathe faceplate is oscillated through an angle just sufficient to enable the segment to be machined. This permits the turning of segments on pieces having projecting members which would prevent them from being revolved continuously in one direction.

Referring to the illustration, the work *A* is oscillated through an angle *a*. The cone pulley *B* is connected to the small driving gear *C*, which, in turn, drives the gear *D* secured to shaft *E*. The gear shown by the dotted lines at *F*, however, is removed when the lathe is used for segment turning. The removable eccentric disk *G* is keyed to the end of shaft *E*.

One end of the driving arm *H* is fitted to a crankpin which is adjustable for the length of throw in a slot in disk *G*. The work *A* on which the dovetail segment is to be turned is mounted on the faceplate *J* and held in place by a stud and a clamping nut *K*. The plate *L* is of hardened steel, and serves as a templet for machining the work to the required irregular form. For non-rigid pieces, this templet may, in addition, serve as a stop for taking the thrust imposed on the work by the cutting tool. The pin *M* must, of course, be withdrawn from contact with the cone pulley so that the oscillating movement can be imparted to the faceplate by the driving arm *H*. Another example of the type of work machined with the segment turning arrangement is shown at *W*.



Lathe Equipment used for Segment Turning

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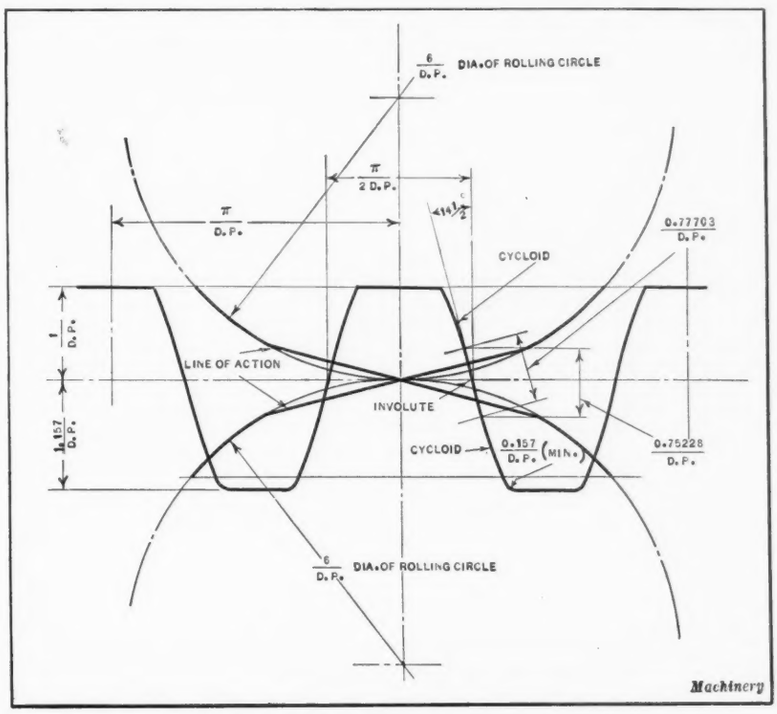
CONGRESS FOR APPLIED MECHANICS

An International Congress for Applied Mechanics will be held at Zurich, Switzerland, at the Federal Technical University from September 12 to September 18.

Spur Gear Tooth Form

A TENTATIVE American standard spur gear tooth form has been completed by sub-committee No. 4 of the Sectional Committee on the Standardization of Gears and approved by the American Engineering Standards Committee. The sectional committee consists of thirty men representing fourteen national organizations, composed of manufacturers, consumers, and general interests. It was organized in June, 1921, by the American Gear Manufacturers' Association and the American Society of Mechanical Engineers, acting as joint sponsors under the procedure of the American Engineering Standards Committee. Benjamin F. Waterman of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman of the sectional committee, and Henry J. Eberhardt, of the Newark Gear Cutting Machine Co., 69 Prospect St., Newark, N. J., is chairman of sub-committee No. 4.

This tentative standard applies both to the 14 1/2-degree composite system (full-depth tooth) and to the 20-degree stub involute system. The basic rack of the composite system is shown in the illustration. The formulas for addendum, tooth depth, thickness, etc., are the same as those now in common use. The dedendum, however, is specified as "minimum," as is also the clearance. A suitable working tolerance is to be considered in connection with all minimum recommendations, and clearance is recommended as minimum so as to allow perfect freedom for necessary cutter clearance on any desired method of producing gears.



Basic Rack for 14½-degree Composite System (Full-depth Tooth)

As the illustration shows, the central part of the basic rack for this composite system, is a straight line which inclines 14 1/2 degrees with the vertical, and the upper and lower portions of the tooth are cycloidal curves. These curves are approximated by arcs having a radius equal to 3.75 divided by the diametral pitch, and they are struck from centers located above and below the pitch line an amount equal to 0.56278 divided by the diametral pitch. Any discussion or criticism of this tentative standard will be welcome, and should be sent to C. B. LePage, assistant secretary, American Society of Mechanical Engineers, 29 W. 39th St., New York City.

Reasons Underlying Tentative American Standard

In order to give the readers of MACHINERY a better understanding of the reasons underlying this tentative standard, the following general statement was secured from Henry J. Eberhardt:

"This composite standard or definition of a tooth form is in response to a long standing desire to have in scientific form the basic rack of the interchangeable system of gearing used for many years in this country and abroad, and usually produced by disk cutters. This proposed rack is not adding another, or new standard, to those now in use, as gears generated for this rack and produced by any system of good gear cutting, will interchange with each other and with gears made to the 14 1/2-degree system of disk cutters.

"It is well known that a straight-sided unmodified basic rack will produce involute gearing, but unless the pressure angle is made much higher than the angles now in use, under-cutting becomes a serious matter on pinions of low numbers of teeth. This interference can be nicely overcome for a single pair of gears by changing diameters and pressure angles, but to have a basic rack that will generate both the gears and pinions for interchangeable purposes, the problem is more complex. It is evident that this system avoids interference by rounding off the tips or addendums of the teeth, and filling in the roots by modifying the involute curve so that it is continued at the tip and bottom as a cycloid curve, thereby strengthening the roots of the teeth and allowing the teeth to have tooth action beyond that which would be obtained with the pure involute. The line of action is therefore longer with the composite system than with the pure involute; that is, the teeth are in action for a longer period.

"The basic rack for the 20-degree stub involute tooth is a straight-line unmodified form. This is being proposed to simplify the decision of designers wishing to adopt stub teeth. There are many systems of various angles and proportions in use, the most popular of which are the Nuttall and Fellows systems. The proposed system will have correct tooth action with the two systems mentioned, and should therefore meet with universal favor for future design, and eventually supersede the others.

"It is interesting to note that the standard American Gear Manufacturers' Association practice, for herringbone gears, uses the same proportion of tooth; that is, the tooth shapes in the plane of rotation, of such herringbone gears, are identical with the tooth shapes generated by a rack proportioned to this proposed standard. There is considerable demand and use for a full-depth 20-degree gear, and it is believed that a standard will be offered in the near future for this purpose."

The following additional comment on the standardization of gear tooth forms was secured from Earle Buckingham, professor of engineering standards, Massachusetts Institute of Technology.

Problem Related to Standardization of Gear Tooth Forms

"The standardization of gear tooth forms presents many perplexing problems. At the present time, there are several

gear tooth systems in common use. The first problem in regard to standardization relates to the selection of some one system as standard in preference to the others. The selection of a single system for this purpose could be justified only if the selected system was better than any of the other systems, or equally good, for all uses and in facility of production.

"Each of the present gear tooth systems now in general use has been developed to serve some particular field of use or method of production, because of the inadequacy—real or imagined—of the existing systems at that time. Therefore the adoption of a single system of gear tooth forms as standard, to the exclusion of all others, would only tend to start a controversy that would probably do more harm than good. Thus standardization activities have been directed toward the formulation of definite specifications for the several gear tooth systems in general use, to the end that all gears of any system, however produced, would mesh and run together properly.

"The next problem that required a solution was to find a simple and effective method of specifying the sizes, shapes, etc., of each gear tooth system. As all interchangeable gear tooth systems are developed from a basic rack form, the specification of the size and form of this basic rack would automatically control the sizes and shapes of all gears of the system. If form cutters were used in production, the shapes of these cutters could be established either from a gear of the desired tooth-number, generated from a cutter of basic rack form, or from a carefully made lay-out. In like manner, the form of any generating tool which was to be used on a gear generating machine could be established.

"As to which of the various systems should be selected as standard, is a matter that is still open. The Sectional Committee on the Standardization of Gears decided to work first on those systems about which some uncertainty existed or where there were several similar systems with minor differences, and attempt to unify them. Thus the first two standard tooth forms to be adopted were the 14 1/2-degree composite tooth form (widely used in the form milling process) and the 20-degree stub tooth form, of which there were several with but minor variations.

"The 14 1/2-degree composite tooth form is probably the most valuable general-purpose gear tooth form that we now have. It was developed originally for use with the form-milling process, but can be made with equal facility on generating machines, such as hobbing machines, by making a hob of basic rack form. The relieving tool for the hob can be made to the form of the tooth of the basic rack, and used without correction. Theoretically, this introduces an error in the form of the hob, but this error is very slight and in a favorable direction; that is, it will produce a gear with a slight relief or modification at the tip and root of the tooth. The tooth action on all gears of this system is good, even with the smaller tooth numbers. This gear tooth system probably has earned for itself a permanent position as the most popular general-purpose gear tooth form. Its greatest disadvantage is the difficulty of making and measuring the composite form for the tools, which has led to the adoption of other tooth forms where extreme accuracy is required for very high speeds and quiet running.

"The 20-degree stub tooth form is widely used in automobile transmissions, and also for heavy mill gearing, where the additional strength of the shorter form is often very desirable. The proposed standard has constant proportions in all pitches which have been approved as satisfactory by the several companies who have hitherto had slightly varying proportions. This new standard will interchange with all the older ones, the only difference being a slight variation in the clearance. In effect, the standardization of gear tooth forms has been limited to the standardization of the tools used to produce them. This seems to be a very desirable limitation of standardization activities along these lines."

Mechanical Exhibits at Railway Convention

A notable convention and exhibition of the Mechanical Division of the American Railway Association was held at Atlantic City, June 9 to 16. The mechanical exhibits contained an unusual number of important developments in railway equipment, machine tools, small tools, and various other machine shop appliances. There were, in all, 339 firms represented.

In the machine shop equipment section there were forty-three machine tool exhibits and forty-two exhibits of small tools and shop accessories. The machine tools included all standard types used in locomotive shops, and also a number of the more special designs. Several of the latter were of the single-purpose type intended exclusively for specific operations in locomotive shops. Practically all the machine tools were in operation, to demonstrate their power, rigidity, convenience of control, or methods of application.

This shop equipment exhibit enabled visitors to see readily and within a comparatively brief time an exceptionally interesting variety of many of the most important and recent developments in machine shop equipment. These exhibits of shop tools now embrace so many different types that a special building is required for them. Inasmuch as practically all of these developments in machine shop equipment have been described in previous numbers of MACHINERY, detailed descriptions will not be given here.

The exhibits of shop tools included everything from small hand-operated and portable tools up to the largest machines, such as heavy lathes, boring mills, planers, etc. Although grinding has long been applied in railway repair shops, the exhibits of grinding apparatus indicated a marked tendency toward greater use of grinding methods in this industry. In addition to the cylindrical and face grinders, special grinding equipment was shown, as, for example, a machine for retruing crankpins and others for retruing cylinders of cross-compound air pumps by grinding instead of turning or boring. Several interesting types of portable machine tools were exhibited, including machines for boring steam cylinders and air pump cylinders; machines for retruing frame jaw faces by milling; machines for retruing crankpins by turning; flange facing and valve-seat facing machines, etc.

In connection with the small tool exhibits there were many actual demonstrations to show their application or to illustrate their superiority as regards convenience or effect on quality of work—in a word, to show the economy of using tools that exist only because tests have demonstrated that they are economical. These special tools included drills, milling cutters, taps, reamers, quick-change chucks, gages, and similar tools. The wonderful capacities of modern drills and milling cutters for rapid drilling and milling were demonstrated by carefully conducted tests.

Although the exhibits in general consisted largely of finished manufactured products, many included raw materials in the form of steels, special alloys, etc., representing notable developments. A careful study of all these exhibits and of the excellent literature accompanying many of them, made it possible for railway executives to acquire in a brief period information about a great variety of modern products allied to the railway field.

During the sessions of the convention committee, reports on many important topics were presented and discussed. The subjects included prices for labor and materials; safety appliances; specifications and tests for materials; loading rules; car construction; tank cars; brakes and brake equipment; couplers and draft gears; locomotive design and construction; electric rolling stock; locomotive and car lighting; utilization of locomotives; and an analysis of relative tracking characteristics.

The attendance was much larger than that of any previous convention, showing that interest in the value of this means of interchanging ideas and of demonstrating modern developments is keeping pace with the great progress being made throughout the various industries allied to the railway field.

ARC OF BELT CONTACT AND TRACTIVE OR GRIPPING POWER

The effect of large arcs of belt contact on pulleys is demonstrated by means of the simple apparatus illustrated in Figs. 1 and 2. A shaft that is free to revolve on ball bearings is fitted at one end with a cast-iron pulley *D*, and at the other end with a pointer *E* and a rod to which is attached a weight *G*. The Lenix belt wrapper *H* and its arm are mounted in a fixed position on a sleeve of the stand. The belt *J*, the weight *K*, and a circular scale constitute the remainder of the apparatus.

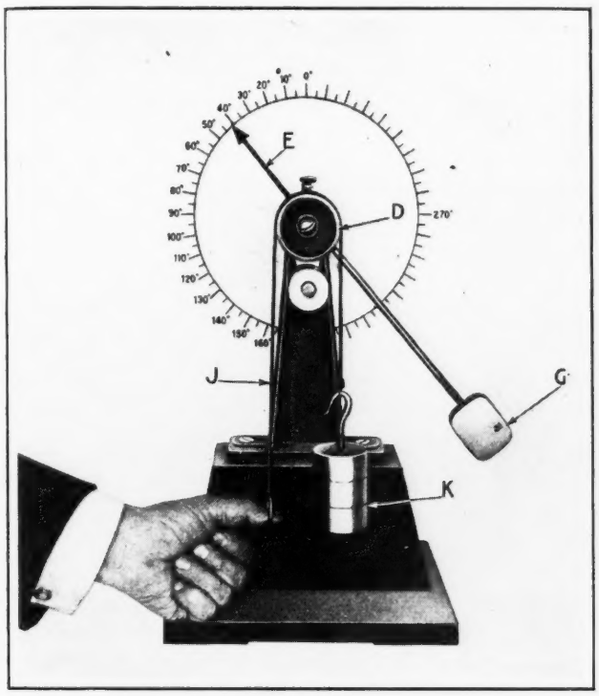


Fig. 1. Demonstration of Belt Transmitting Capacity when Arc of Contact is 180 Degrees—note Position of Pointer and Weight G

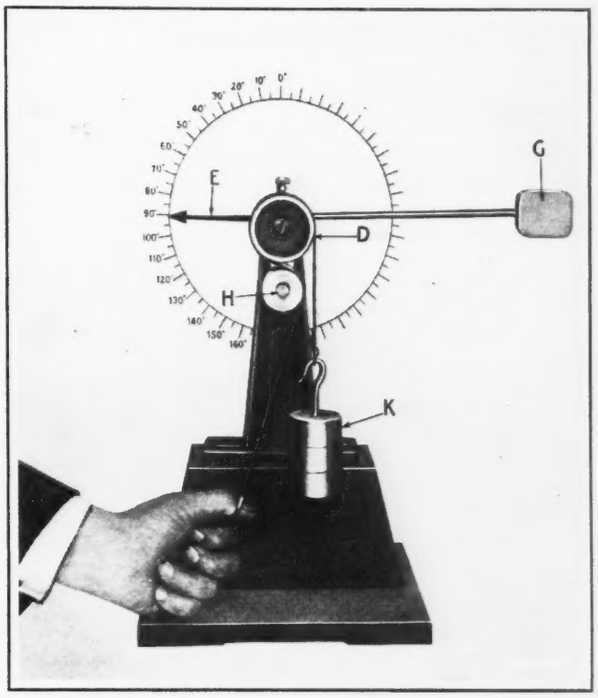


Fig. 2. Change in Position of Pointer shows how Tractive Power is increased when Belt Contact is 250 Degrees

In Fig. 1 is shown the equivalent of an ordinary open belt drive with 180 degrees arc of belt contact. Constant initial tension is established by the counterweight *K*, and the maximum torque the belt will transmit under these circumstances is found by forcing the belt ring down with the thumb until the weight has deflected to a point where the belt begins to slip. This point is found to be equivalent to a 40-degree deflection on the scale.

In Fig. 2 is shown the equivalent of a flexible idler system with 250 degrees arc of belt contact, the belt passing around the idler pulley of a Lenix drive. The initial tension is the same as in Fig. 1, because the weight *K* is unchanged. Again the belt ring is forced down with the thumb until the weight has deflected to a point where the belt begins to slip. This point is now found to be equivalent to a 90-degree deflection on the scale. This shows that with a fixed initial tension, the increase in the arc of belt contact from 180 to 250 degrees greatly increases the tractive or gripping power of the belt. This is the fundamental principle of the Lenix drive.

Fig. 3 illustrates how the foregoing principle is applied in practice to a short-center drive. In addition to increasing the tractive or gripping power of the belt, the flexible idler system automatically maintains the tension in the slack side of the belt; automatically compensates for changes in the length of the belt due to atmospheric or load conditions; saves bearings because of reduced bearing pressures; and permits the use of high pulley ratios, ratios up to 1 to 15 being common. The apparatus described in the foregoing is used by F. L. Smidth & Co., 50 Church St., New York City, in demonstrating the Lenix drive.

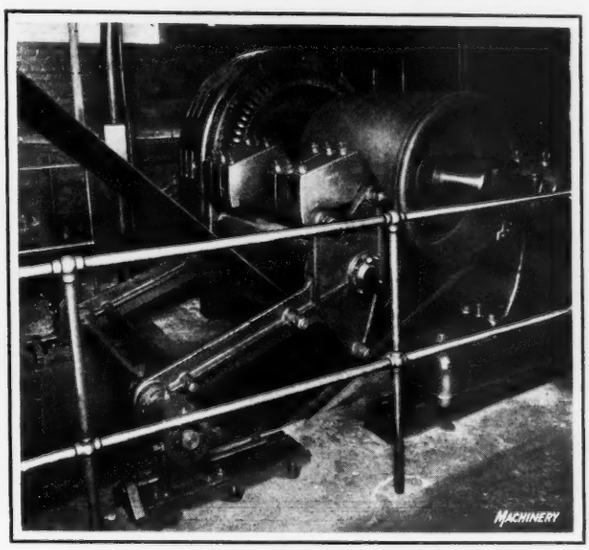


Fig. 3. Typical Short-center or Lenix Belt Drive

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GRAMME CENTENARY

The present year marks the centenary of the birth of Gramme, one of those inventors in the electrical field whose name is known to every engineer, but of whose life comparatively little has been recorded. Gramme was born near Liége, Belgium, in 1826, and was first apprenticed as a carpenter, but gained scientific knowledge by attending some lectures at Liége. Later he moved to Paris, where, in 1871, he took out a patent on a dynamo with a ring armature. This type of dynamo had already been invented by the Italian physicist Antonio Pacinotte, but Gramme's invention was entirely independent, and he is accorded the honor of having devised the first practical electric current generator yielding continuous current. One of Gramme's machines was brought to England in 1873, and was used for lighting the clock tower of the House of Commons; five years later another one of his machines was utilized for supplying current to arc lamps in the first open space in Paris to be lighted by electricity. The decoration of the Legion of Honor was bestowed on him and he received the Volta Prize from the French Academy of Sciences.

Laying Out and Machining Large Pump Cylinders

By W. WHEATLEY

THE writer's experience in machining large pump cylinders, as described in this article, was obtained while operating a boring mill in a shop located in a copper mining center. The pump cylinders, one of which is shown at *W* in Fig. 1, are machined from tough bronze castings weighing about 1800 pounds. Each cylinder, with its valve chambers, constitutes one of four units of the complete pump. The base *B*, Fig. 2, is secured to the pump frame, and the flanges *A* and *D* are connected with manifolds, the flange *D* being connected to the suction side. In order to facilitate assembling, the distance from the center line of the cylinder to the face of the flange *A*, and the distance from the center line to the face of flange *D*, as well as the vertical spacing of the two flanges, must conform closely to the measurements on the drawing.

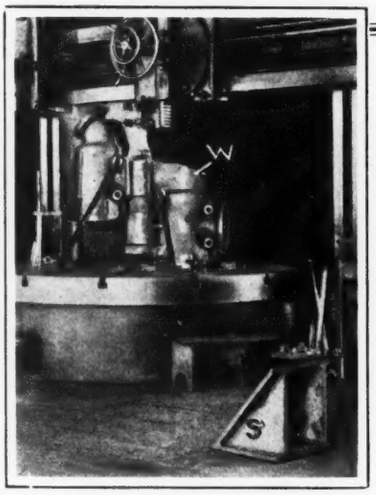


Fig. 1. Pump Cylinder mounted on Boring Mill Table

Before starting the job, the writer was informed that trouble had been experienced in machining the castings so that the center of the flange *D* would be located in the proper position. The method that had previously been employed in laying out the work was approximately as described in the following:

The casting was placed on the boring mill table with center pieces placed in the ends of the cored cylinder bore and the valve chambers. The center of each of these members was then laid out on the inserted pieces by taking measurements from the exterior of the casting. The center of the base *B* was also laid out as accurately as possible. Next, the casting was laid down on its side and adjusted vertically to bring the centers of the flanges *A*, *D*, and *C* at the same height from the surface of the boring table. Vertical lines were then drawn through the centers of each flange and also through the center of the base *B*. A line was next scribed all around the casting at the same height as the centers of the flanges. The center of the cylinder bore, as determined by the intersection of the horizontal and vertical lines previously scribed, did not usually coincide with the line scribed all around the casting. Hence, it was necessary to relocate or change the first center to correspond with the position represented by the line scribed around the casting.

After the cylinder center line had been located as described, the casting was set up on the boring machine table, with the flange *A* resting on the surface of the table. The casting was then moved back and forth on the table until the line scribed across the flange *E* was parallel with the surface of the table. This brought the lines scribed through the centers of surfaces *C* and *B* the same height from the table. The surface gage was then used to scribe a line across the flange *D* at a point 17 inches above the center line of the cylinder. Next a line was scribed on each side of flange *D* which intersected line *KP*. This point of intersection located the finished face of the flange.

Lines were then scribed on each side of the valve chamber *E*, parallel with the table surface and at the specified height above the face of the flange *A*. Next, the casting was set up with flange *E* located on the table, the lines scribed across the flange *A* and the line *GH* being used to line up the work. The accuracy of the lay-out was then tested by setting the surface gage point 32 1/16 inches above the center of flange *A*. If the point of the surface gage coincided with the point previously laid out on line *KP*, the work was considered to be properly laid out. Generally, however, this was

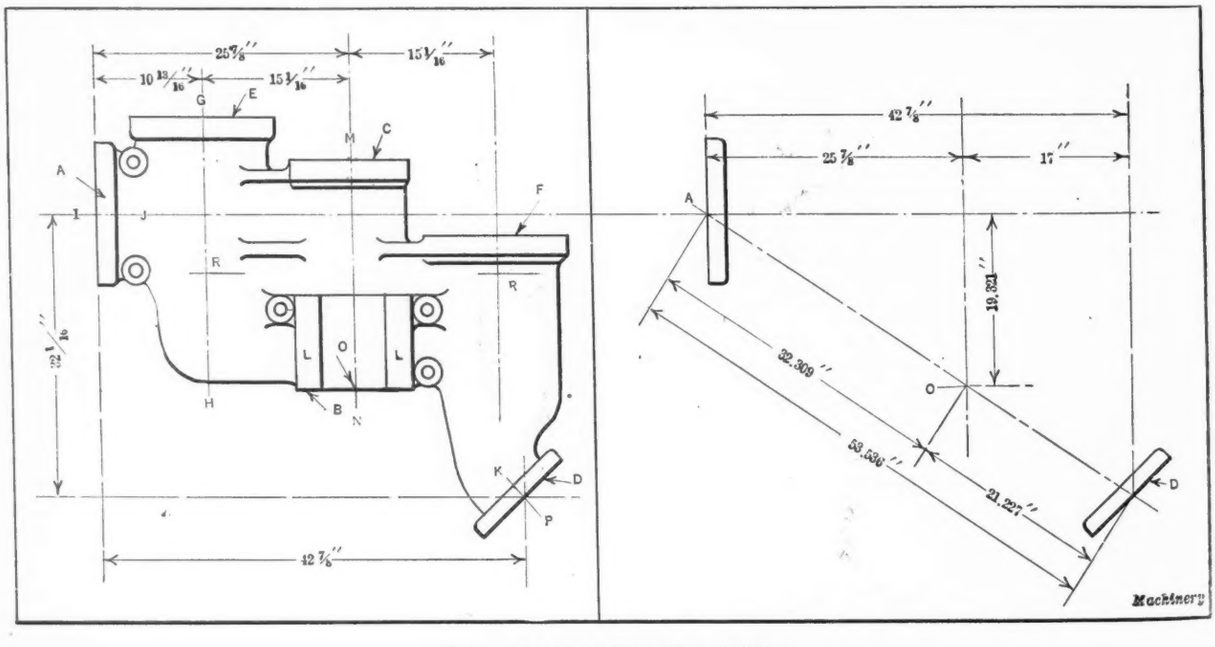


Fig. 2. Details of Bronze Pump Cylinder

not the case, although if it was fairly close, the lay-out was considered to be as accurate as could be obtained by the methods employed. If the point of the surface gage showed that the lay-out was considerably out of line, the laying out process had to be repeated and an allowance made somewhere to compensate for the error.

The writer concluded that the error in laying out by the methods employed was due primarily to the impossibility of locating the center of the base *B* accurately from the rough outline of the base of the casting. Other factors, such as casting shrinkage and pattern sagging, also made the problem of obtaining an accurate lay-out more difficult. For this reason, the writer adopted a plan for laying out the work, which was based on the length of the diagonal *AD* rather than on the center line alone. As this dimension was not given on the drawing, it was calculated and recorded as indicated in the diagram at the right of Fig. 2. The dimensions *AO* and *OD* were also calculated and indicated on the diagram.

The procedure followed by the method previously employed was repeated up to and including the scribing of the vertical lines through the center of each flange. After this had been done, the dimension 53.536 inches was carefully laid off on the flanges *A* and *D*, the points being kept on the lines *IJ* and *KP*, allowing the same amount of stock to be removed from each flange. Point *O*, which located the center line of the cylinder, was then laid off on the line *AD*.

The three essential locating points (namely, the centers of the faces of the flanges *A* and *D*, and the center of the bore or cylinder) being now definitely located, the casting was set up on the flange *A* and adjusted so that the point located on flange *D* was 42 7/8 inches above the point indicating the face of the flange *A*. With the surface gage set to the specified height for the point *O*, lines were scribed across *B* and *C*, thus locating the center line of the cylinder. Lines *GH* were then scribed on each side of the casting, after which the casting was set up with the flange *E* resting on the table, and trued up by means of the lines scribed on flange *A* and by the line *GH*. Next, the surface gage was again set to a point 32 1/16 inches above the center of flange *A*. If the point of the surface gage coincided with the point located on the flange *D*, the lay-out was considered to be correct, and the exact positioning of the point on flange *D* was accomplished.

Lines were scribed at *R* for convenience in making future set-ups. A circle was scribed on the base *C* about the center of the base, and the casting set up as shown in Fig. 1 for the first machining operation, which consisted of facing the base *B*. After completing this operation, the lugs *L* were drilled for the hold-down bolts. A pedestal of sufficient height to raise the flange *D* above the surface of the table was then bolted to the base *B*. This pedestal was provided with projecting ends at the top and bottom. One of the ends was machined to fit into a recess in the base of the casting, and the other projected into the center hole in the boring machine table. The work was thus properly located for boring the cylinder.

In locating the casting for boring the valve chambers, the lining up was generally done by taking measurements from the exterior surfaces, if the cored holes were properly centered. The pedestal was used to support the casting for each of the three boring operations, being shifted on the table in order to align the bores with the center. Not counting the drilling operations, six set-ups were required for machining the casting, the flange *D* being faced last. The flange *A* was secured to the angle-plate shown at *S*, Fig. 1, for machining the flange *D*.

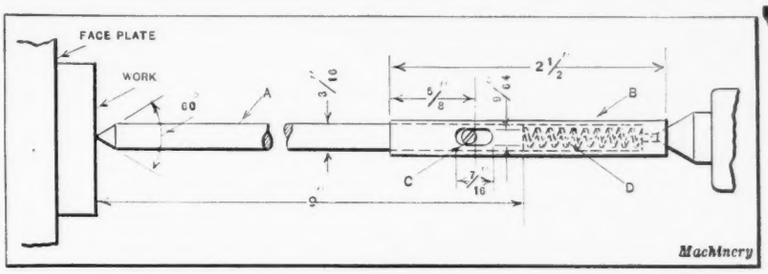
"WIGGLER" FOR CENTERING WORK ON FACEPLATE

By ARTHUR R. MYERS

In the accompanying illustration, is shown a "wiggler" for use in locating work on a lathe faceplate preparatory to drilling and boring a hole, the position of which is determined by a prick-punch mark. The point *A* of the "wiggler" is a free sliding fit in the body *B*. A slot is cut in body *B*, as shown, and the screw *C* inserted in a tapped hole in point *A*. The head of screw *C* permits a limited movement of point *A* in body *B* against the tension of spring *D*.

The locating of a piece of work so that a prick-punch mark on its surface will be in line with the center of the lathe spindle is accomplished in the following manner: The work is secured to the faceplate with the prick-punch mark as near the spindle center as it is possible to locate it by using the point of the tailstock center as a guide. The point of the "wiggler" is then placed in the prick-punch mark and the tailstock center advanced to support the other end and slightly compress spring *D*. Spring *D* allows point *A* to move in or out as the piece is shifted on the faceplate.

The "wiggler" should not revolve when the faceplate is revolved, but the point *A* should follow the prick-punch mark. An indicator is next mounted in the toolpost, and the contact point brought up against the side of the point *A*, as close to the work as possible. The indicator will show the direction in which the work must be moved to bring the prick-punch mark into line with the center of the spindle. The indicator point is left in contact with the "wiggler" point while relocating the work, so that the distance the work is moved can be determined. The point of the prick-punch used in laying out the work should be ground to the same angle as the "wiggler" point.



"Wiggler" for centering Work on Faceplate

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AMERICAN PATENTS AND TRADEMARKS ABROAD

Relief from former conditions affecting American patent rights in foreign countries resulted from the International Convention for the Protection of Industrial Property, which was held at The Hague, according to the official report by Commissioner of Patents Thomas E. Robertson, who attended as chairman of the American Delegation. Practical elimination of the risk of forfeiture of a patent for non-working or for non-payment of taxes through accidental causes is described by the patent commissioner as a change of outstanding importance in the revised convention signed by every one of the thirty-two countries that were represented.

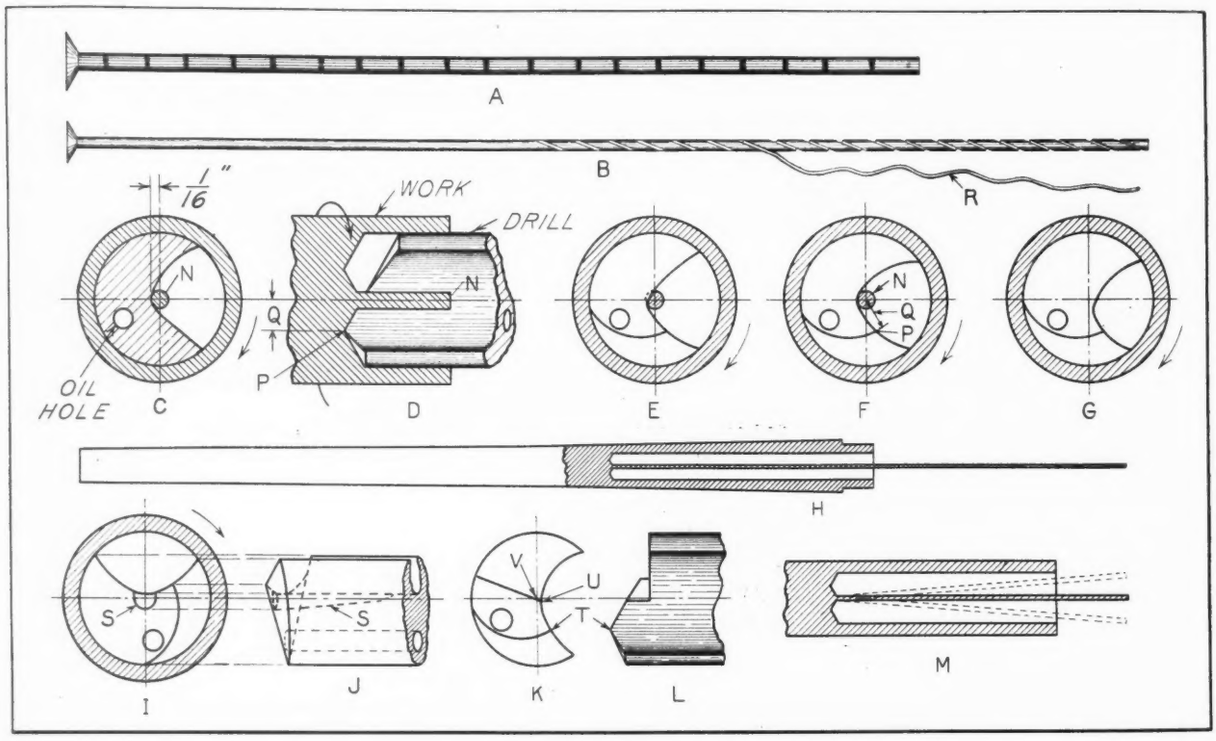
An agreement was reached that the period of three years, which must be allowed before any penalty can be imposed for non-working, is to be reckoned from the date of the grant of the patent instead of the filing of the application. Another important development is the provision as to the cancellation of fraudulently registered trademarks, furnishing "an effective remedy against piracy of well-known trademarks." Also, the amendments with relation to unfair competition will be of benefit, especially in those countries that have not developed, as have the United States and Great Britain, a well-defined system of jurisprudence with respect to unfair competition. The adoption of the present convention represents a long step forward in the direction of doing away entirely with requirements of working in order to maintain a patent in force, and diminishes the risk of a patentee losing his rights as in former years.

Deep-hole Drilling

By F. W. BACH

SOME interesting results are often obtained in drilling deep holes in the barrels of shotguns and rifles. For example, cores such as shown at *A* and *B* in the accompanying illustration are sometimes obtained in drilling shotgun barrels. These cores, or "wires," were produced in drilling two shotgun barrels, each 30 inches long. The core shown at *A*, obtained from one barrel, was 30 inches long and 1/8 inch in diameter. The cross shade marks at irregular intervals indicate the points at which the drill was removed for sharpening. This frequent sharpening was necessary, as the drill did not have a sufficient amount of clearance at the center, and this fault could not be remedied until *Q* indicate, respectively, the core, the high point of the drill, and the distance of the point *P* from the center about which the work revolves. These references are the same as in view *D* except that *Q*, in view *D*, is indicated on the work and not in its true position on the drill. At *E* is shown the end view of a drill, the groove of which was not ground out to a radius equal to the radius of the core, as is necessary to provide free cutting.

At *B* is shown a core several inches longer than the work from which it was removed. It shows a spiral effect for more than one-half its length, and a division of the core with a fine end *R* branching off from the main part. The spiral groove



Diagrams used in explaining Deep-hole Drilling Operations

the hole already started was finished. After the drill had been sharpened, it would cut freely for a depth of about 1/2 inch, and the cutting edge would then become dull, so the sleeve which rotated the gun barrel was stopped. The diameter of the hole drilled in this case was 0.685 inch.

The making of the core *A* was the result of grinding the drill groove, by mistake, 1/16 inch below center, for the whole length of the drill, as indicated in the diagram at *C*. This caused the drill to have the same action as a hollow mill, the tooth or point leaving the core *N*. The greater the depth of the groove below center, the larger will be the diameter of the core. The radius of the groove should always be equal to or greater than the distance the groove is cut below the center, in order to have the drill cut freely and not ring the walls of the hole.

Referring to view *D*, which shows a side elevation of the drill point and a cross-section of the work being drilled, it will be noted that the high point *P* of the drill is located at a distance *Q* from the center about which the work revolves. This explains the formation of the rivet-shaped head on the end of the core *A*.

At *F* is shown diagrammatically the point of the drill as it appears when ground to cut freely. The letters *N*, *P*, and is also shown on the main part where the fine end was forced out. The spiral effect and the splitting of the core was caused by the groove in the drill being too deep and the oil-hole drilled too near the center, which left a very thin web between the oil-hole and the groove. The pressure of the work caused this web to crack, and eventually it broke out and sheared the stock until the rotation of the work stopped. The drill was then removed and resharpened, after which it cut the smooth portion of the core shown at the left-hand end.

At *H* is shown a shotgun barrel which is only partly drilled and has a core projecting several inches from the end. In one case, a core 30 inches long and 1/32 inch in diameter was obtained from a 30-inch shotgun barrel when it had been drilled only half way through. When the drill was resharpened and the drilling of the hole completed, another core of the same length as the first one was produced. The second core had a head at the end where the point of the drill broke through the work. With the same drill, cores 60 inches long and 1/32 inch in diameter were obtained in drilling 30-inch shotgun barrels. The writer kept two of the 60-inch cores and two of the 30-inch cores for some time. These cores were often examined with considerable interest by visitors.

On conducting an investigation to determine the conditions resulting in producing cores that were longer than the work drilled, the writer found that the groove as shown at *G* was not milled to the center of the drill. In order to make the drill cut, it had been ground out at the point, as indicated in the views *I* and *J*. The groove *S* was ground deeper than necessary, however, being 1/64 inch below the center at the point of the drill and tapering back to the milled surface. As the depth of the hole increased and the core became longer, the tapered groove caused the core to be bent back and forth with a twisting motion at every revolution of the work. This motion is indicated by the dotted lines in view *M* and was the action which caused the cores to be stretched or drawn out. The speed of the work when the 60-inch cores were produced was approximately 900 revolutions per minute.

Some workmen eliminate the necessity of having the drill groove ground to the center by cutting away the drill point, as indicated in views *K* and *L*. The clearance part of the end of the drill is ground away to a depth of 1/4 inch below the cutting or lip part of the drill. The straight side of the ground away portion passes through the center of the drill. This produces a cutting lip of somewhat different shape, which extends from the outer point *T* to the point *U*, and from there to the point *V*, as illustrated. In order to obtain the best results, the groove in a deep-hole drill should be about 0.002 to 0.003 inch below the center. This would result in the production of a core 0.004 to 0.006 inch in diameter, which would be kept broken up by the chips and would not, therefore, clog up the chip passage, as would a core of larger diameter.

* * *

WING-TYPE FLUSH-PIN GAGE

By A. LISKA

At *B*, Fig. 1, is shown a wing-type flush-pin gage having the same gaging steps *a* and *b* as the regular flush-pin gage shown at *A*. At *C* is a perspective view of the sleeve. When the depth *M* is being gaged, the pin *T* is turned by means of the knurled handle. If the wing *W* swings over surface *b* but is stopped by the step *a*, the depth of the hole is correct within the required limits. If the wing passes over step *a*, the depth of the hole is less than the minimum depth permissible. On the other hand, if the wing is stopped by the step *b*, the hole is deeper than the maximum depth allowed.

The actual construction of the sleeve is shown in views *D* and *E*. It will be noted that grooves are provided to facilitate grinding the steps and to eliminate contact edges near the pin shaft. The practical application of the wing-type flush-pin gage is shown in Fig. 2. The contact end of gage *A* is of the plug type, while that of *B* is of the cup type.

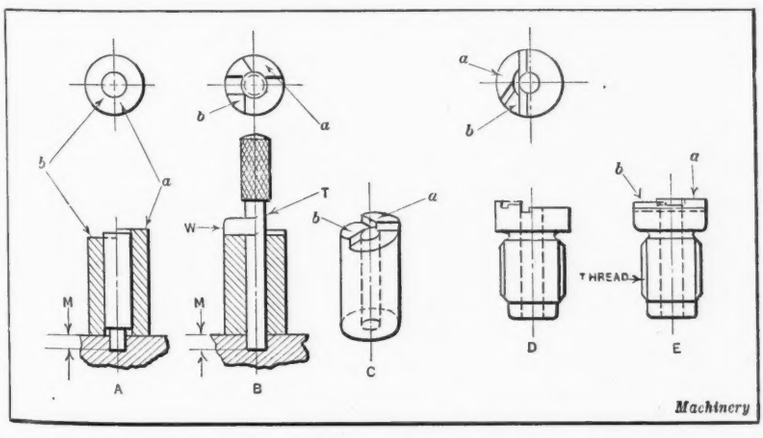


Fig. 1. (A) Ordinary Type of Flush-pin Gage; (B) Wing Type of Flush-pin Gage

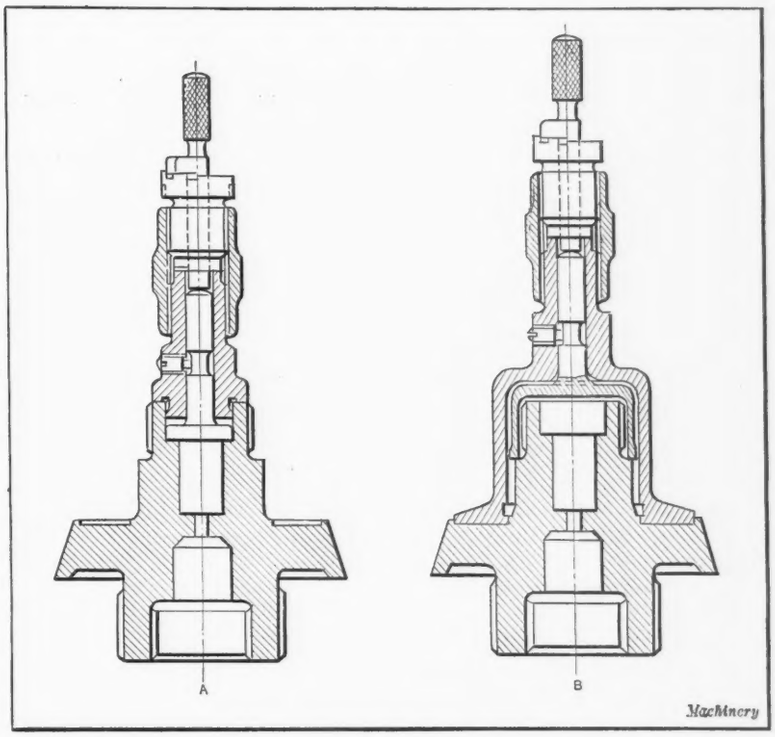


Fig. 2. Application of Wing Type Gages

The wing type of gage eliminates any doubt as to whether a piece should be passed or rejected, and thus argument over the reading of the gage is avoided. The operator is less subject to fatigue when using this type of gage than when employing the usual types. The gage is not easily damaged and can be employed by unskilled men.

* * *

S. A. E. SPRING MEETING

The spring meeting of the Society of Automotive Engineers was held at French Lick Springs, Ind., June 1 to 4. The program included a number of papers of interest not only to automotive engineers, but to engineers in general. This is especially true of the papers read on gearing. While the application of the gears referred to in these papers are specifically found in the automotive field, a great deal of the information contained would be of interest to any engineer who has to deal with gear transmissions. One of the papers, which dealt with the design, production and application of hypoid rear axle gears, is abstracted on page 865 of this number of MACHINERY. L. R. Buckendale, of the Timken Detroit Axle Co., Detroit, Mich., read a paper on "The Automotive Worm-gear." In addition, there were sessions on fuels and lubrication, anti-freezing solutions, tires, and other subjects of especial interest to automotive engineers.

* * *

INTERNATIONAL ADVERTISING CONVENTION

The International Advertising Convention of the Associated Advertising Clubs of the World, held in Philadelphia June 19 to 24, dealt with a number of subjects of interest alike to those who make use of advertising as an important aid in making sales and to those who prepare and publish this advertising. Different sessions were devoted to different types of advertising—trade journal, magazine, and newspaper advertising. Circulation statistics were also dealt with.

The Machine-building Industries

THE business outlook at the beginning of the summer is favorable. The steel industry maintains, on an average, the same production rate as for the last two months. The recession in the automobile industry is comparatively slight. Activity in building shows little or no signs of abatement, and the railroads are carrying more freight than ever before. Employment conditions indicate that the purchasing power of the public continues large. Labor is well employed at good wages—in some instances, at rates that constitute a peak. Crop reports are favorable, and generally speaking, there are no clouds on the industrial horizon.

Commenting on the general business situation, the American Exchange-Pacific National Bank of New York states: "With the crop outlook good for this year, the maintenance of industrial schedules, plenty of money for legitimate trade use, the volume of business—wholesale and retail—holding up well, expanding exports, and building activity up to the present on a par with last year, the general situation contains elements that appear to make for continuing prosperity and the employment of all available labor."

A great deal has been said and written about a recession in the building industry. *Commerce and Finance* points out that in the reports from the principal cities there is little evidence to be found of a recession. In New York, Chicago, Philadelphia, Cleveland, Dallas, Minneapolis, Atlanta, Boston, Detroit, Baltimore, and many other places, building activity is well maintained, and in most of these cities is running well ahead of a year ago. St. Louis, Buffalo, and Indianapolis are among the few large cities that report less building. Engineering construction contracts awarded since January 1 are approximately 15 per cent greater than in 1925, and while at present there is a decrease in new contracts, the volume, week by week, is still ahead of a year ago.

The Machine Tool Industry

Information received from machine tool builders as to the present trend of machine tool sales varies to a considerable extent. While here and there demand continues brisk, there has been a gradual reduction in the general volume of business. The demand for forging machinery seems to be improving, and at least one plant in this field is working more nearly to capacity than at any time in the last five years. Bolt and nut machinery is not in great demand, but other lines of forging equipment have been creating new markets for this line of machinery. The railroads have been buying to some extent in this field. There appears to be a normal demand for steam hammers, and a fair amount of foreign trade in this line is reported. Those builders of machine tools and accessories whose product goes to the oil fields report good business.

In the small tool field, the demand was unusually good during the first quarter of the year, showing some recession in April, an improvement in May, and a slight recession at the present time—a common seasonal occurrence. Makers of die-heads and threading tools in general have enjoyed an unusually active business, some firms in this field reporting the biggest business in the history of their enterprise during the early part of this year.

The tool, jig, and fixture business in Ohio and Michigan shows the usual seasonal let-up, but several of the plants engaged in this field state that it is possible to obtain a very satisfactory volume of business, although prices, due to severe competition, are unusually low.

In the machine shop accessories field, a fairly even volume of business is being done. There has been a recession in the unusually large demand for die-castings last winter, partly due, no doubt, to the summer schedules of the automobile factories. The industrial gear industry is proceeding at an even pace, with a satisfactory volume of business.

The exports of machinery in general remain heavy, and machine tool exports are increasing. In April, the last month for which complete statistics are available, machine tools were exported to a value of $697,700. Among these exports were engine lathes to a value of $67,000; automatic screw machines, $77,000; milling machines, $147,000; drilling machines, $94,000; and grinding machines, $108,000. The total value of the machinery exports from the United States in April was $38,755,000.

The Iron and Steel Industry

Beginning about May 1, the new business booked by the United States Steel Corporation began to run ahead of the preceding month. The corporation maintains operations at about 90 per cent of capacity, with heavy rail orders and renewed demand for structural steel reported. The independent mills average about 80 per cent of capacity. Recently there have been recessions in certain lines of iron and steel products, with gains in other directions, leaving the total at practically the same level. The railways, for example, have placed large orders, while the automobile industry shows evidence of curtailment. Structural steel sales are large, but sales of steel sheets are decreasing.

The Automobile Industry

While there has been a curtailing in the output of automobiles from the record figures in March and April, both production and sales are maintained at a surprisingly high level. The output at the present time is closely adjusted to sales, and though the latter were somewhat delayed by the late spring, they appear now to run at record figures; but all makes of cars do not share equally in the exceptional demand. General Motors reports sales exceeding the figures of any previous years. Some dealers were, doubtless, overstocked earlier in the year, but conditions now appear to approach normal stocks. The second-hand car, however, presents an unusually difficult problem this year, as more used cars are said to be in the market than ever before. It is expected that many dealers may be in difficulty on this account. The truck and bus business is reaching a level never before approached, and there is no evidence of any falling off in demand for these types of vehicles. The passing by Congress of the bill providing for increased aerial equipment for the Navy is likely to stimulate the airplane motor and plane industry.

The Railroad Situation

The railroads continue to be heavy buyers of iron and steel products. It is of interest to note that the railroads buy over $400,000,000 of these products annually, nearly one-third of which is in the form of rails. The total purchases of the railroads from all industries in 1925 amounted to nearly $1,400,000,000.

The railroads have on order over 600 locomotives and nearly 50,000 freight cars at present. More than 40,000 freight cars were placed in service during the first five months of the year, and in the same period, over 700 locomotives were added to the present railroad equipment. Freight loadings have run heavier than in 1925 right along. During the first four months of the year the railroads handled the heaviest freight traffic, as far as loadings of revenue freight were concerned, that has ever been moved during a corresponding period of time.

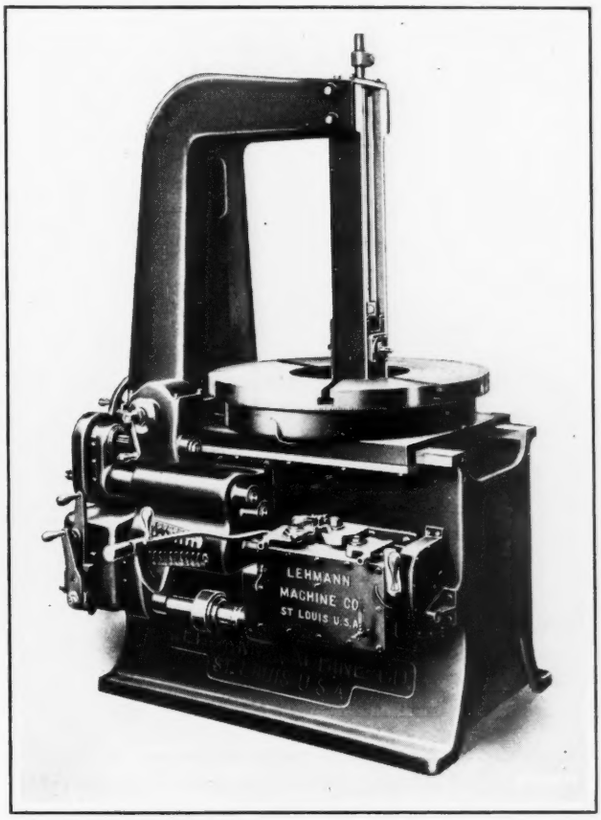
The operating efficiency, measured by such indicators as train loadings and speed of handling freight, showed a further increase during the early months of the year, adding to the important gains made in 1925. Railroad building, which for several years has been at a standstill, except in Florida, has been resumed in some parts of the country.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

LEHMANN OIL-GROOVE MILLING MACHINE

A machine designed primarily for use in railroad shops for milling oil-grooves in locomotive crown brasses, but which may also readily be adapted to other work of a similar nature, has recently been brought out by the Lehmann Machine Co., 3571 Chouteau Ave., St. Louis, Mo. It has been demonstrated by experience that the most effective arrangement of the oil-grooves in a crown brass is to have two grooves in the bearing surface parallel with the axis and located 45 degrees from the center of the bearing surface radius. Two diagonal grooves connect one end of each parallel groove with the opposite end of the other so as to form an X. It is preferable to cut the diagonal grooves deeper at the apex where the brass is usually thickest and wears the most. Experience has also shown that when the grooves are cut from the solid, better service is obtained from crown brasses than when the grooves are cast. The new machine is designed to cut oil-grooves of the type described, with a cutter feed of 4 or 6 inches per minute. The full depth of the grooves may be cut at one time, and the relative depths of the side and apex grooves may be selectively predetermined.



Lehmann Oil-groove Milling Machine for Locomotive Crown Brasses, etc.

A head carrying a three-groove end-mill of the desired size travels in the slides of the central vertical column. This column is rigidly secured at the bottom, and is fastened at the top to the heavy main column which bridges over from the back of the machine. The table is furnished with a device for holding the brasses in position and means for easily determining the correct location. The table is moved laterally until the cutter is fed to the desired depth in the brass. There is a rotary movement of the table which coordinates with the vertical movement of the cutter-head in cutting the diagonal grooves.

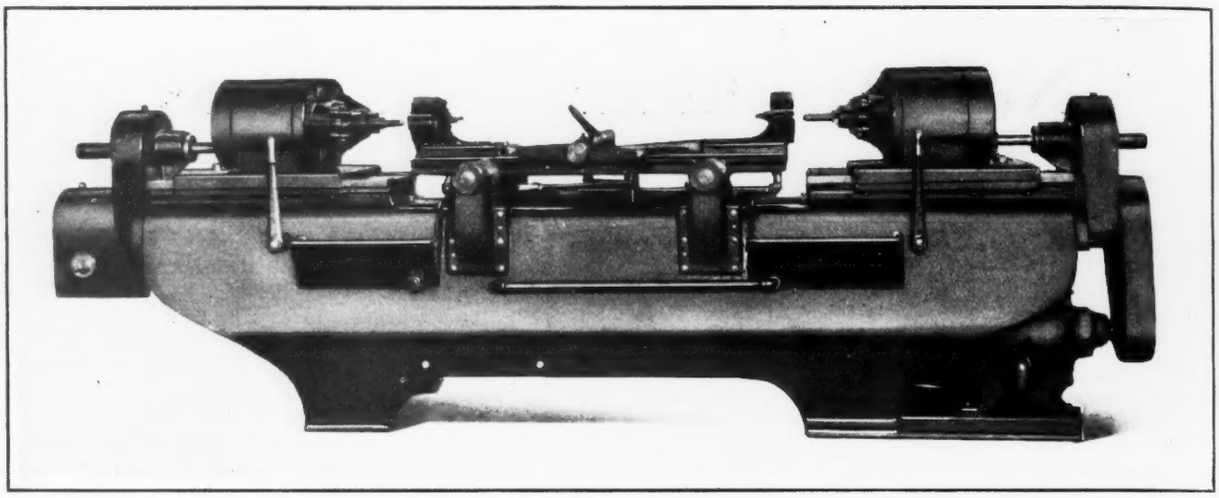
Forty quick changes of feed for the rotary movement of the table are obtained through the feed-box. An index on this feed-box indicates various lengths of the straight grooves to which the diagonal grooves are formed, and the operator only needs to drop the plunger into the hole that designates the desired length of the straight grooves, in order to set the machine for an operation. The operation is controlled by one handle which, when in a central position, causes a straight vertical movement to be imparted to the head. When the handle is moved to the left, a diagonal groove is cut to the left, and when it is moved to the right, a diagonal groove is cut to the right. The operation is completed with four movements of the control handle. Neutral positions are provided between all the different feed positions of the handle.

Stops having a graduated index are furnished for both the upper and lower positions of the cutter. These stops are set before an operation to suit the length of the slot desired, thus relieving the operator from the necessity of throwing the control handle at precisely the right time. When the feed of the cutter is stopped at the end of its movements, it remains idle until the control handle is thrown into the succeeding operative position.

The chips accumulate inside the machine base, and are removed through an opening provided for that purpose. All working parts are protected from chips, the feed-screw under the head being entirely enclosed by means of a telescopic cover. A five-horsepower motor mounted on the back of the machine drives through a silent chain. The latter is furnished with an oil retaining cover. A countershaft may be substituted for the motor when it is desired to drive from a lineshaft. All gear-boxes are enclosed and retain oil, with the exception of the quick-change box which has a central oiling reservoir. The worm and gear of the table run in an oil bath, which also supplies lubrication to the table bearings. Simple gear changes can be made to modify the relative feed movements of the machine so as to obtain other arrangements of oil-grooves. The machine has a capacity for work from 7 to 14 inches in diameter and up to 22 inches in length. The weight of the machine and motor, skidded, is approximately 4650 pounds.

HOEFER REAR-AXLE DRILLING, BORING AND REAMING MACHINE

The special double-end machine here illustrated is designed for machining the roller-bearing seats in automobile rear axles and, at the same time, drilling two groups of holes used for attaching the brake units. The machine is a recent development of the Hoefer Mfg. Co., Inc., Freeport, Ill. Mounted on the ways of the bed are two horizontal heads, each of which carries two form cutters for roughing and finishing the roller-bearing seats. The spindles that hold these cutters are provided with a longitudinal adjustment to permit accurate setting of the tools for depth of cut, and also to provide means of compensating for grinding the tool. In addition to the form cutters, a cluster of eight drills surrounds the roughing tool of each head so that while the rough-boring operation is in process, a group of eight holes is being drilled in each end of the rear axle.



Hoefer Double-end Drilling, Boring, and Reaming Machine for Rear Axles

Power for driving the machine is derived from a motor mounted within the base, which makes the whole unit self-contained. From the motor power is transmitted to the main spindle through a set of sprockets and a silent chain, and from thence to each individual head through spur gears. Spindle speeds commensurate with the size of the tools and the work to be performed are obtained through ratios of gears within the heads. Ball bearings are provided for the spindles, and the mechanisms of the head units run in a bath of oil so that constant lubrication of all friction surfaces is insured.

The work-holding fixture, which is mounted in the center of the machine, is of unusual construction. The main part or base of the fixture slides on two horizontal bars, the supporting brackets being clearly shown in the illustration. Lateral motion of the fixture from one spindle in the head to the other is obtained by operating the horizontal lever in the center of the machine, which functions through a cam. Motion of the fixture in both directions is limited by positive stops that automatically align the work relative to the two spindles.

In view of the fact that locating surfaces on the work itself are limited and the work must be brought into accurate alignment with the spindles, two movable locating units are mounted on the fixture base. These units are operated through the double hand-lever in the center of the fixture, which moves both units in or out simultaneously. Hardened tool-steel bushings in both the holding units locate the work. These bushings are also used to pilot the form tools in the heads, while groups of bushings are provided for guiding the drills.

After the work has been placed in the fixture, it is centralized and locked in place with a rapid movement of the double hand-lever. The fixture is then moved into the first operating position, and the feed engaged by moving either one of the two vertical handles near the ends of the machine. These handles are connected, for the convenience of the operator. The feed is obtained through a set of cams mounted on a shaft that runs the full length of the machine. These cams are arranged to give the following cycle of movements to the tool-heads: A rapid approach, a cutting feed, a rapid reverse, and a dwell. The feed is automatically disengaged at the end of each cycle.

When the first operation has been completed, the work-holding fixture is moved into the second position to bring the work in line with the tools that finish the roller-bearing seats. The cycle of head movements is then repeated. In the base of the bed, there is a large tank for storing cutting lubricant, which is fed to the tools by means of a geared pump. The latter is also located within the bed. Ample catch basins at the front and rear of the machine conduct the coolant back into the main tank in such a manner as to prevent it from overflowing on the floor. Although this machine was designed and built particularly for the class of work referred to, it will be evident that the principles involved in its construction make it readily adaptable to a variety of similar work.

WARDWELL BAND-SAW FILING, SETTING AND JOINTING MACHINE

Band saws can be filed, set, and jointed in one operation in a machine recently placed on the market by the Wardwell Mfg. Co., 110-112 Hamilton Ave., Cleveland, Ohio. This machine is built in two styles, the model K being intended for woodworking band saws from 1/8 to 2 inches wide, having from 2 to 15 teeth per inch, and the model K-2, for medium or spring tempered metal-cutting band saws from 1/8 to 2 inches wide, with any number of teeth per inch up to 26. The machine is equipped with a double-pawl positive feed, of which one pawl works on each side of the file. As the machine is fully automatic, no attention is required from the operator after it has been started.

In operation, a cam connected to the main drive shaft raises the file slide frame at a slight angle from the vertical, so as to give an oblique movement to the file, as in hand filing, and thus allow the file to enter and leave any hook on the saw teeth. On the point of the cam there is a steel roller which operates the horizontal slide. There is an adjustment for the length of stroke and for the amount of stock filed from the face of the teeth. An elevating screw raises or lowers the saw at the point of filing, and another at the point of setting. Two adjustable cams that work in unison rigidly

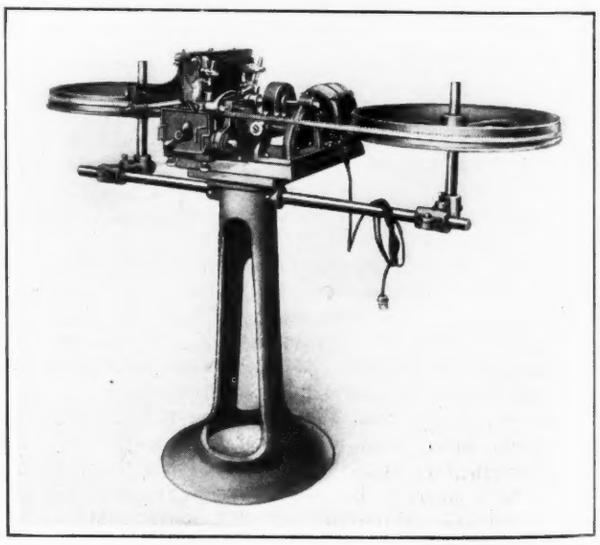


Fig. 1. Wardwell Filing, Setting, and Jointing Machine for Band Saws

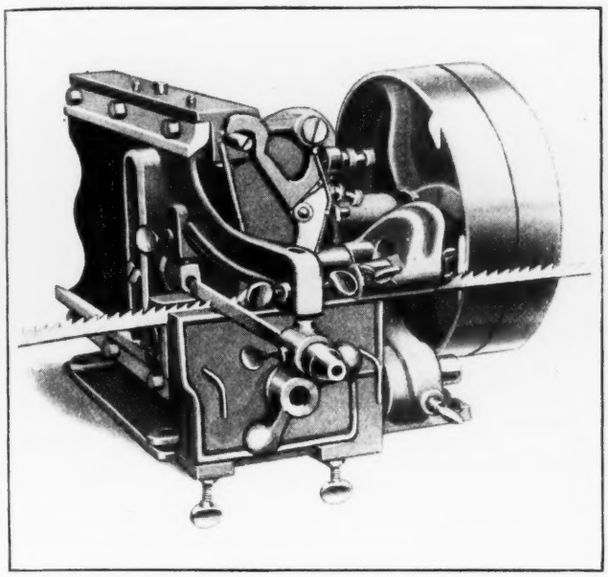


Fig. 2. Mechanism that files, sets, and joints Band-saw Teeth in One Operation

tighten the saw when it is being filed and set, and then are automatically released, leaving the saw free to be advanced by the feed pawl. Before the file starts the next stroke, the vise is again automatically tightened to insure a firm grip on the saw.

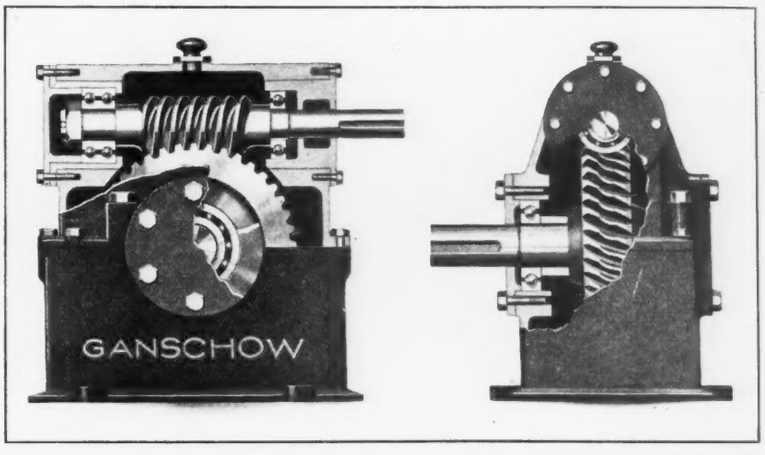
The setter is governed and timed by an eccentric roller geared to the main drive shaft. As the file sharpens a tooth, the setter points set another tooth. This setting device rocks on a steel bearing, and can be moved back and forth on a sleeve so as to bring the points in line with the teeth on saws of different pitch. With the file resting in a tooth, the device is moved to bring the setter points opposite to or in line with a tooth, and is then locked. The points can be adjusted to set as much or as little as desired, and each point is made to give the proper clearance behind the cutting edge of the teeth. The operation is performed at the rate of 70 teeth per minute. Saws can be quickly placed in the machine for the operation.

Equipped with a belt drive and without the pedestal illustrated, the machine weighs about 98 pounds. It may also be furnished with a direct-connected alternating- or direct-current motor of 1/6 horsepower rating. In this case, the machine and motor are mounted on a cast-iron base, and the equipment weighs approximately 145 pounds.

GANSCHOW WORM-GEAR SPEED REDUCER

A worm-gear power transformer of the construction illustrated is now being introduced to the trade by the William Ganschow Co., 16 N. Morgan St., Chicago, Ill. All moving parts of the reducer are fully enclosed in a cast-iron housing, which completely protects them from damage by dirt, grit, or moisture. They run in an oil bath, the base of the housing forming a reservoir. Either the worm- or gear-shaft extensions may be reversed at any time. Standard units are equipped with a gear made of a special bronze. The smaller units have a solid bronze gear, while in the larger units, the gear consists of a bronze rim that is shrunk and studded on a cast-iron center. The worm is made of 3 1/2 per cent nickel steel, carburized, hardened, and ground. The pressure angle of the thread is 22 1/2 degrees.

Anti-friction thrust bearings are used throughout, either ball or roller bearings being provided in accordance with the service demanded. The gear bearings are held securely in place by clamping plates. The front radial worm bearing is free to float to compensate for any elongation of the worm or expansion of the housing that might be produced by heat.



Ganschow Worm-gear Speed Reducer

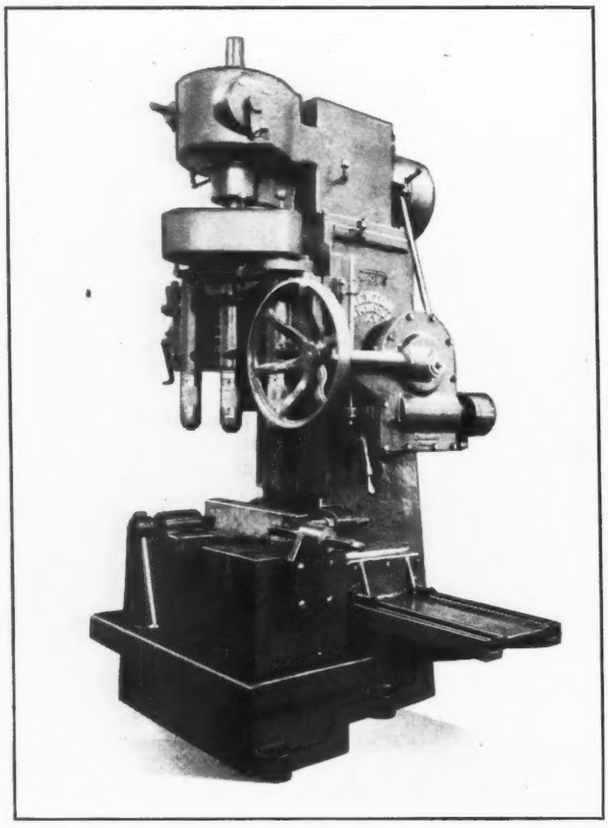
BACK-GEARED DRIVE FOR MOTORS

A back-geared attachment designed to operate under the most unfavorable conditions is announced by the General Electric Co., Schenectady, N. Y., for use with its "500-series" induction motors. This attachment is of strong construction, and is easily installed and adjusted. The motor and back-shaft pedestals are bolted and doweled to a large base casting. A special unit-type pedestal is used, one casting forming the housings for the back-shaft bearings. Thus maximum rigidity and permanent alignment of shafts and meshing of the gear and pinion are assured. The back-shaft is provided with shoulders that limit end play. It is supported by two double-seated, split bearings contained in dustproof housings that hold sufficient oil for a number of months' operation. A split gear-case, fabricated from steel plates, protects the gear and pinion from dust and retains the grease or oil in which the gear runs. Two standard gear ratios are available. Steel or fabroil pinions with cast-iron gears may be used.

NEWTON RAIL DRILLING MACHINE

A Newton improved drilling machine, built by the Consolidated Machine Tool Corporation of America, Rochester, N. Y., is shown in the accompanying illustration. This machine is intended especially for rail shops, and is of a simple design. It is fitted with three spindles, which are adjustable sidewise on a vertical saddle to obtain a maximum center distance of 12 inches between each spindle, or 24 inches between the two outside spindles. Adjustments are made by hand through screws on the saddle, and after an adjustment has been accomplished, the spindles are clamped in position by means of T-head bolts. The spindles are equipped with ball thrust washers. A counterweight for the saddle is contained in the upright and connected to the saddle by two chains.

The speed-box and the driving head constitute a complete unit. Speed changes are made at the front of the head, and are obtained through triple sliding gears. A lever that functions through a rack and pinion is operated to shift the sliding gears. The feed is taken from the main driving shaft at the rear of the speed-box, and transmitted through bevel gears and a vertical shaft to a worm and worm-wheel located at the rear of the right-hand side of the machine. The worm is provided with a slip friction which acts as a safety device in case a drill sticks. The final drive to the feed from the worm-gear is through a rack and pinion inside the column. The feed can be engaged or disengaged through the capstan handle. At the end of an operation, the feed is knocked out by means of a rod with an adjustable collar that comes in contact with the feed trip arm on the saddle.

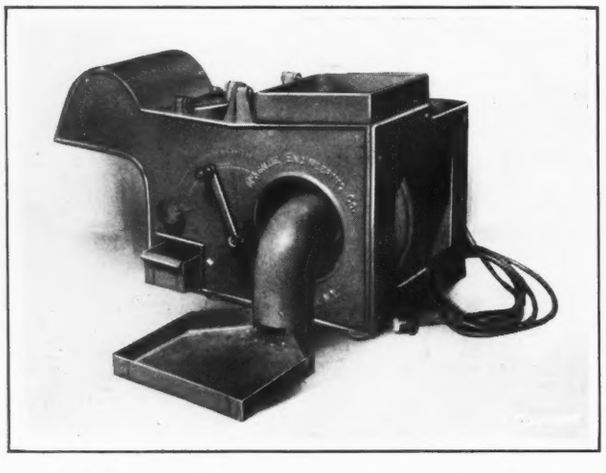


Newton Improved Rail Drilling Machine with Three Spindles

The work-table is integral with the column, and is provided with a T-slot for clamping rail supports in place. There is a squaring block having an adjustment from the center of the spindles of from 1 3/4 to 4 inches. A clamping screw is located at the front of the table and a stop-screw at the right-hand end. The column is provided with a trough to catch the cutting lubricant, and a motor bracket is bolted to the right-hand side of the column. Screws on the motor bracket provide for adjusting the motor rails to tighten the driving belt. All gears are enclosed and run in oil.

MCKENZIE WORK AND CHIP SEPARATOR

A small separator has recently been brought out by the McKenzie Engineering Co., P. O. Box 519, New Rochelle, N. Y., for separating chips from screw machine products, such as parts of watches, clocks, optical goods, cameras, and various instruments. Parts may also be separated from sawdust after having been tumbled, and fiber and aluminum pieces can be handled. The equipment operates on the principle of the larger separator built by the same company.



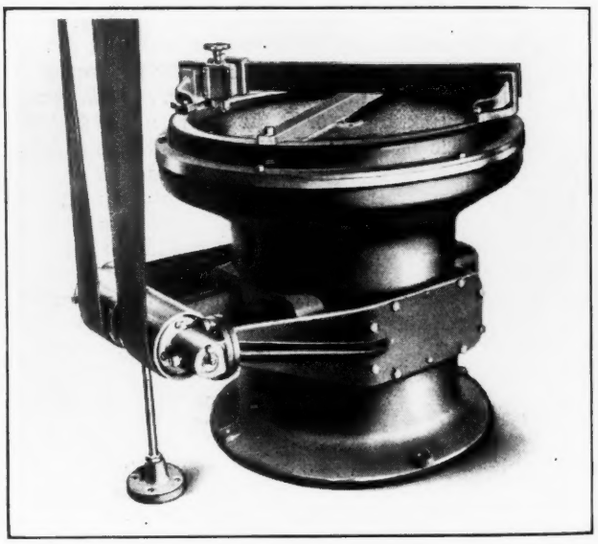
McKenzie Equipment for separating Chips and Screw Machine Products

The material is put into the work-box and pushed into a vibrator through an opening measuring 3 by 1 inch. In this vibrator, it is loosened and spread out and the chips are blown through the hood, while the finished parts drop into the pan provided for them. Parts that are very small and light may be separated by means of the exhauster attachment which is shown in position on the machine. In operating this attachment, the material is placed in the work pan and pushed to the inlet opening in the elbow. The chips are then sucked up through the elbow and exhauster, and discharged through the hood, while the finished parts drop through a hole in the bench or table into a box. The lever is operated to regulate the air blast for both blowing and exhausting; the smaller the parts are, the less air is required.

Separation is accomplished rapidly, only about a minute being necessary for separating a day's output of a small automatic screw machine. The equipment is driven by a small 1/4-horsepower motor which may be connected to an ordinary lighting socket. The equipment measures 28 inches long by 14 inches wide by 16 inches high, and weighs approximately 156 pounds.

GARDNER DISK GRINDER

The latest addition to the line of disk grinding machines built by the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis., consists of a No. 86 machine equipped with a horizontal



Gardner Small-sized Grinder with Horizontal Disk

30-inch steel disk wheel. On other machines of this type built by the same company, a 53-inch disk wheel is the standard size. The new grinder meets the demand for a smaller machine that economizes in floor space and handles work that is not large enough to require a larger disk member.

The steel disk wheel is mounted on a heavy supporting flange, 16 inches in diameter, which is machined, balanced, and fitted and keyed to the tapered end of the vertical driving spindle. The spindle is turned from crucible steel, ground and mounted in radial and thrust ball bearings, for which lubrication is insured. Mounted on the spindle is a pulley, the belt of which passes over two adjustably supported, double ball-bearing, oil-lubricated mule pulleys, and from there to the driving pulley. A standard dressing device is provided, as illustrated.

This machine is also available with an alternating-current motor drive. The motor is of the vertical type, mounted in the base of the machine, fully enclosed and self-ventilated. In such an installation, the rotor shaft serves as the machine

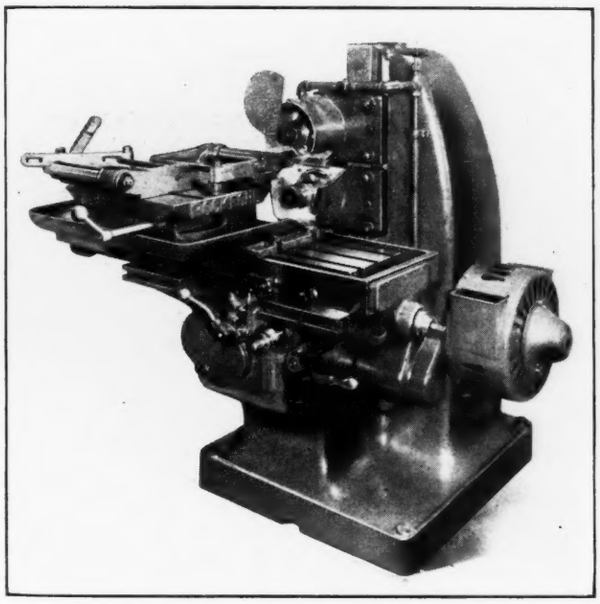
spindle, the remainder of the machine being identical with the belt-driven equipment. The floor space occupied is 46 inches long by 38 inches wide.

ROCKFORD DOUBLE-SPINDLE "RIGIDMIL"

A "Rigidmil" designed for milling both bolt pads on each side of automobile connecting-rods and for splitting the main bearing has recently been built by the Rockford Milling Machine Co., Rockford, Ill. As may be seen in the illustration, there are two cutter-heads on this machine, one above the other. Both cutter-heads are adjustable vertically in unison by means of the main adjustment at the front of the machine, and the space between the two heads may also be altered to suit conditions. Cross adjustment is accomplished by means of the quills. Each spindle carries a gang of cutters.

Two fixtures for holding the work are mounted on an index base, which permits loading and unloading to be done while a milling operation is in progress. The small end of the connecting-rods registers on a pin, while the large end is supported by a bar and held with a swinging floating clamp that locks the cut-off cap in place until the cutters have returned to the starting position. The float prevents the caps from moving, and thus obviates breakage of the cutters on the return stroke. The machine is equipped with an automatic rapid traverse.

The cycle of an operation is to load the fixture in the loading position, index the fixture, engage the rapid approach

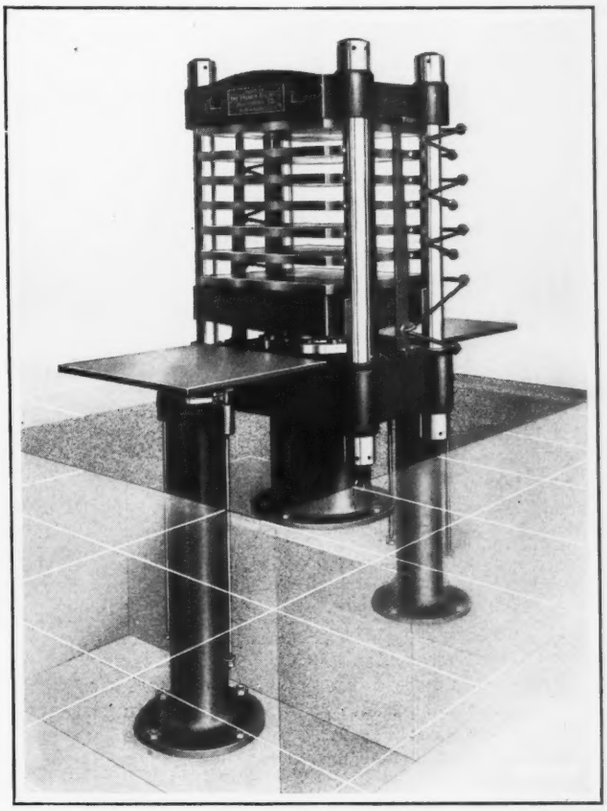


Rockford "Rigidmil" arranged for milling and sawing Automobile Connecting-rods

and feed, and unload and load the fixture, which has now returned to the loading position. At the completion of the cut, the table returns automatically to the indexing position. A feed of from 5 to 6 inches per minute is used in the operations for which this machine is intended.

HOT-PLATE MOLDING PRESS

Hard rubber and bakelite parts may be molded in the six-opening hot-plate press recently brought out by the French Oil Mill Machinery Co., Piqua, Ohio. The hot plates are rolled steel sheets with drilled passages and, in the machine illustrated, are 42 inches square. Mounted at both the front and back of the press is a 42-inch square table, and both of these tables are elevated by means of low-pressure hydraulic cylinders. Two presses make a complete unit, and are set side by side a certain distance apart with roller conveyors connecting the front and rear tables of both presses. With



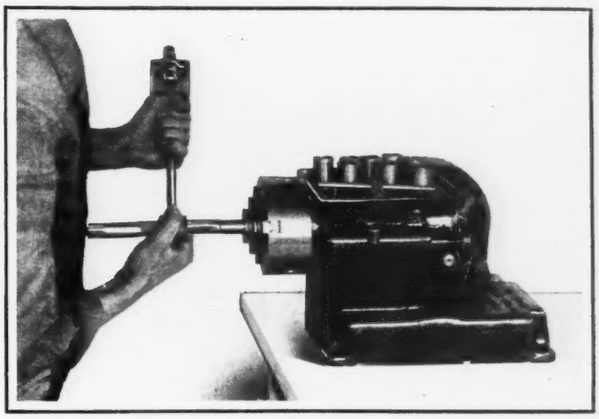
Hot-plate Molding Press built by the French Oil Mill Machinery Co.

such an installation, three sets of molds only are required for the two presses. One press is started when the other is half way through a cycle, and one set of molds is reloaded while the two presses are in operation.

When an operation in one press is completed, the molds are pushed out of this press and stacked up on one of the elevating tables. At the same time, freshly charged molds are pushed into the press from the other elevating table, and the press is closed up with a minimum loss of time. The discharged molds are then pushed on the adjoining roller conveyor, one at a time, and this is easily accomplished by adjusting the elevating table to the proper height. The molds are then opened, recharged, and stacked on the adjacent elevating table of the other press, ready for reloading this press. The molds always travel in the same direction.

VAN NORMAN "REAMO"

A bench type of motor-driven reaming machine has recently been brought out by the Van Norman Machine Tool Co., 150 to 200 Wilbraham Ave., Springfield, Mass. While this machine was designed primarily for use in automotive



Reaming Connecting-rod Bushings on the Van Norman "Reamo"

service and repair shops for reaming such parts as pistons and connecting-rods, it is also well adapted to general machine shop use when a considerable amount of hand-reaming is necessary. In this equipment, the reamer shank is held in a motor-driven chuck, and the work is slipped over the reamer, as shown in the illustration. The work is held at the waist line, so that the reamer easily enters and follows either one or two bearings in a straight line. The work is removed from the tool with the latter still revolving, thus obviating any marks on the surface reamed.

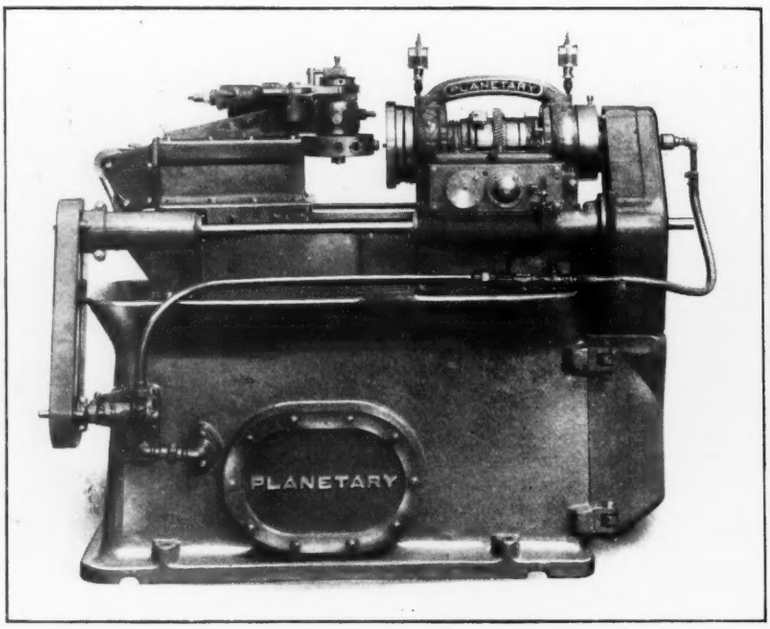


Fig. 1. Hall Planetary Thread Milling Machine arranged to handle Automobile Hub-cap Nuts

Reamer shanks from 1/4 to 2 1/2 inches in diameter can be gripped in the chuck. The chuck spindle is driven by worm-gearing from a shaft driven through gears from the motor shaft. The motor is of 1/4-horsepower capacity, and the reamer runs at 30 revolutions per minute.

HALL PLANETARY THREAD MILLING MACHINE

The line of thread milling machines built by the Hall Planetary Co., Fox St. and Abbotsford Ave., Philadelphia, Pa., has recently been expanded to include the automatic machine illustrated in Fig. 1. The machine is shown equipped for threading automobile hub-cap nuts, but it may be adapted to handle any small work that must be threaded externally or internally. In the general construction of the planetary head, the new machine follows the design of the Hall planetary thread milling machine described in August, 1923, MACHINERY. The chief difference between the two machines lies in the work-holding turret with which the automatic machine is equipped. Fig. 2 shows views of the work at *A* and *B*, and the threading tool at *C*. The channels in the shank of the cutter are used to supply coolant to the work from the machine spindle.

The machine is driven by a motor in the base, which transmits power through a silent chain to a supplementary shaft mounted at the back of the machine, as shown in Fig. 1. The cutter-spindle, in turn, is driven from the supplementary shaft by a silent chain. The work-holding turret is moved to and from the cutter-spindle through the medium of a wire cable which runs over grooved pulleys and is actuated by a cam-roll mounted on a stud that is located directly under the planetary head. On this particular machine, the turret is brought into the forward position by means of a spring; however, for heavier work, an air or oil cylinder is provided in place of the spring-and-cam construction.

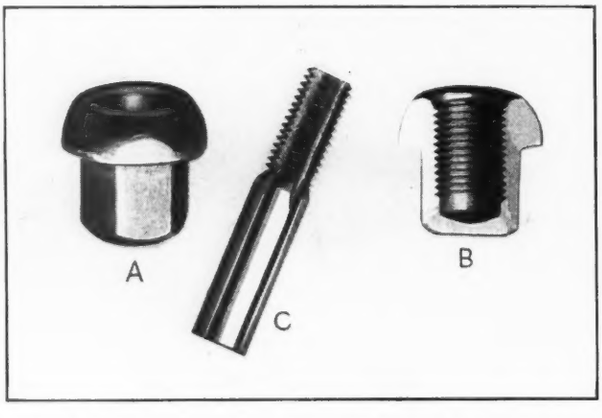


Fig. 2. (A) Automobile Hub-cap Nut; (B) Hub-cap Nut cut in Two; (C) Cutter used in milling the Thread

In the operation of the machine, a quantity of nuts are put in a hopper, which is not shown. The nuts are then mechanically fed one at a time into the hexagonal bushings of the turret. After each piece of work is indexed into the threading position, the turret advances until the ball end of the nut is located in a cone-shaped hole in a stationary plate attached to the planetary head, the cutter extending through this plate. While the nut is held firmly in the turret and located in the stationary plate, the milling cutter moves radially to the required depth and makes one complete revolution "planetarywise," at the same time advancing the distance of the thread lead. The milling cutter then goes through the reverse of this step and returns to the starting position, after which the work-holding turret recedes and indexes the next piece of work into place to be threaded. As the threaded nuts are indexed to the back of the machine, they are automatically ejected from the turret by cam-controlled internal plungers.

Since it is necessary that the threaded hole in the nut be concentric with the ball end, the shoulder of the ball end bears against three hardened buttons contained in the bushing, and these buttons hold the nut square during the thread milling operation.

The cutter speed in this particular operation is 1018 revolutions per minute. The production ranges between nine and twelve nuts per minute, depending upon the toughness of the steel, the thread being the 9/16 inch S.A.E. standard and milled 3/4 inch deep in a blind hole.

DETROIT CENTERLESS GRINDER

The latest development of the Detroit Machine Tool Co., Detroit, Mich., is a 5-C shoulder grinder which may be operated as a full-automatic or a semi-automatic machine. In addition to shoulder grinding, the machine can also be employed for "straight-through" grinding. The main feature is a camshaft which controls the various movements in the grinding process. The cam controls the grinding wheel, and is also the means provided for timing and feeding the work to the machine. A hand-lever which engages a clutch is operated to actuate the camshaft. If the machine is set for full-automatic operation, the cycle will be performed over and over again, after the clutch has been engaged, grinding from five to eighteen pieces per minute, depending upon the work being ground, the finish desired, etc.

To take care of variations in stock, the grinding wheel cam has been so designed that it can be quickly adjusted for any depth of cut between 0.005 and 0.020 inch. Through the use of this ad-

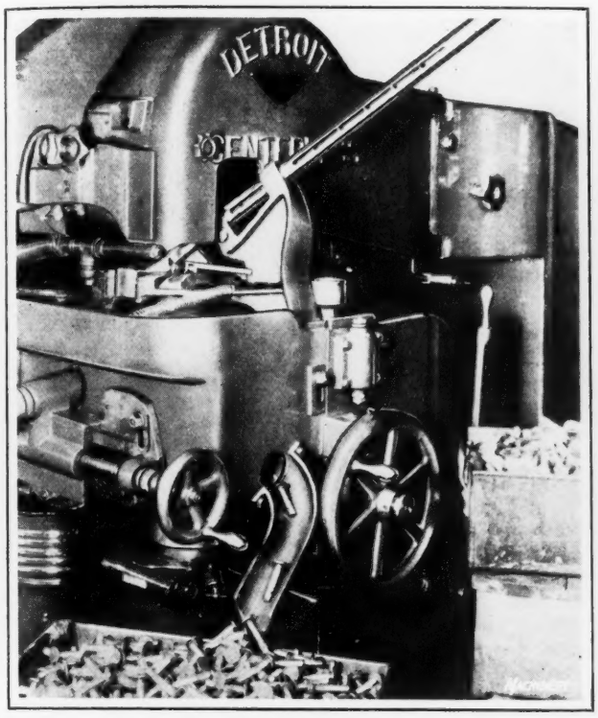


Fig. 1. Detroit Centerless Grinder equipped for grinding Tappets automatically

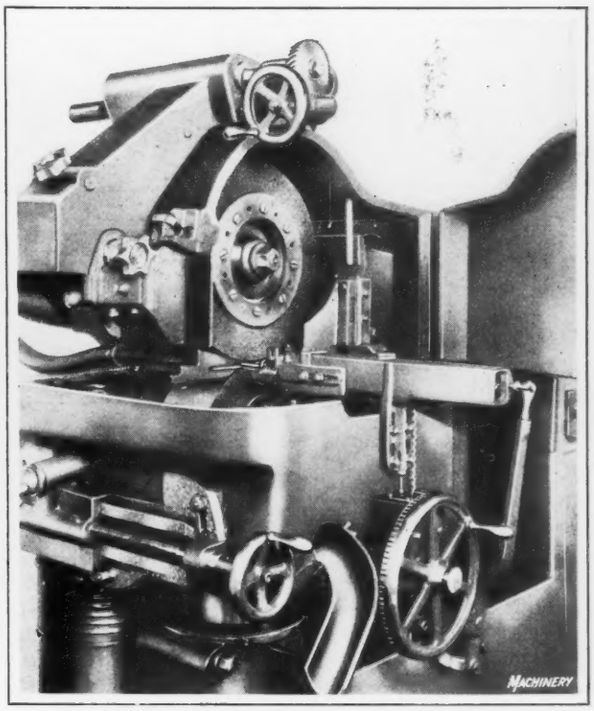


Fig. 2. Grinder with Wheel Guard removed to show Semi-automatic Fixture in Position

justment, the full path and shape of the cam may be used for roughing or finishing, as the case may be. The grinding wheel spindle is carried on an eccentric quill, 7 1/4 inches in diameter, which provides means for the automatic feed.

The work is fed to the machine from an automatic magazine. During a cycle, the grinding wheel moves down to the work, oscillates endwise at the completion of the stroke, and returns to the loading position. While the grinding wheel is in the latter position, the ground piece falls from beneath the wheel and another piece automatically moves into position to be ground. The entire work of the operator consists in keeping the magazine loaded.

For cases where the production is not large enough to warrant full-automatic operation of the machine, a semi-automatic fixture has been designed. This fixture takes any length of work from 1 to 8 inches under the head, and is mounted on the machine by simply tightening four studs and attaching a chain. With this fixture, the operator places the work on a loading finger, moves a lever toward him to bring the work between the wheels and, at the same time, brings the camshaft into operation for one complete cycle. While one piece of work is being ground, another is placed on the finger ready to be brought between the wheels for the next cycle.

Fig. 1 shows the machine equipped for grinding tappets, the pieces being fed from a magazine, and ejected on the work chute. Fig. 2 shows the centerless grinder with the wheel guard open and the semi-automatic fixture in position. There is a piece of work between the grinding wheels. In Fig. 3, the machine is equipped for grinding Ford triple gear pins. A plunger and gravity chute are provided for automatically feeding the work.

In addition to shoulder work ranging up to 8 inches in length under the head, this machine also handles straight work from 1/16 to 4 5/8 inches in diameter and up to 16 feet long. Work exceeding 4 or 5 feet in length requires special supporting devices. Two grinding wheels, 18 inches in diameter, with a 4-inch face width, are regularly furnished, but any wheel with a width up to 8 inches, can be accommodated. The work-driving wheel is of a hard composition which gives friction without an abrasive action, for rotating the work. The standard wheel is 10 inches in diameter and 8 inches face width, but where shoulder work under 8 inches long is to be ground, a driving wheel of corresponding width is supplied. Truing devices for the upper and lower wheels are constructed as part of the machine, and both wheels can be trued without disturbing the set-up of the work. An 80-gallon tank is cast integral with the base to hold the grinding solution. The machine is electrically driven throughout.

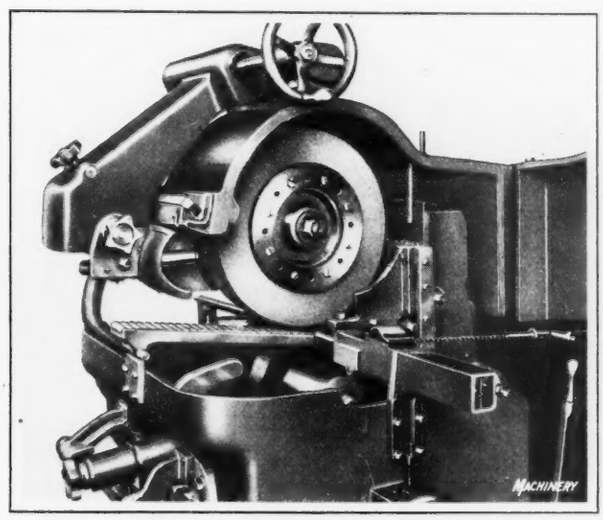


Fig. 3. Gravity Chute and Plunger for automatically feeding Pieces of Work

ZEISS OPTICAL DIVIDING HEAD

A dividing head manufactured in the optical works of Carl Zeiss, Jena, Germany, is being placed on the market by the George Scherr Co., 142 Liberty St., New York City. The main feature of this dividing head is the means provided to insure accurate settings. There is a glass dial mounted directly on the spindle, and this dial is graduated to 360 degrees around the periphery. While indexing the spindle, the dial graduations may be conveniently observed through a microscope as the hand-wheel is being turned, and when the desired setting has been obtained, the spindle is locked in place. Since the readings are made on a dial mounted directly on the spindle and the dial is never contacted with, inaccurate settings cannot result from any lost motion that might occur through wear in the mechanism. Readings are made di-

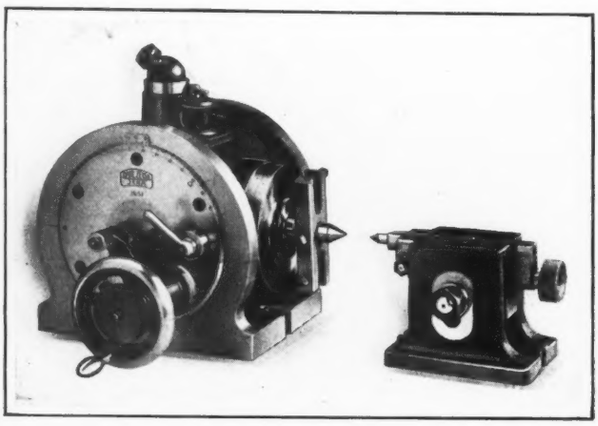


Fig. 1. Zeiss Optical Dividing Head

rectly in minutes, and can be closely estimated to 20 seconds.

The spaces between the degree graduations of the glass dial are magnified sixty times by the microscopic eye-piece, and appear about 1 3/4 inches apart. A second vernier scale of 60 minutes is projected by the ocular into the field of observation, and, as the graduations on this scale appear about 0.03 inch apart, it is safe to estimate settings within 20 seconds, as previously mentioned. The vernier scale remains stationary in making a setting, while the degree graduations of the dial pass under it. In Fig. 2 the lines opposite the large numerals represent the degree graduations of the glass dial, while the smaller numerals are opposite the vernier lines that indicate minutes. In a setting where the graduations of the dial would be in the same relation to the vernier scale as shown in Fig. 2, the reading would be 45 degrees, 23 minutes, 30 seconds. The eye-piece of the microscope is mounted on top of the dividing head, and may be swiveled into any position to facilitate observation of the dial. A small incandescent lamp illuminates the dial graduations.

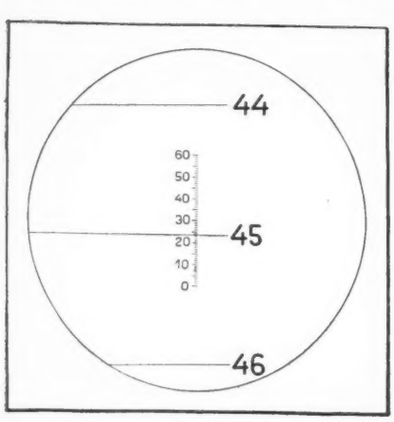


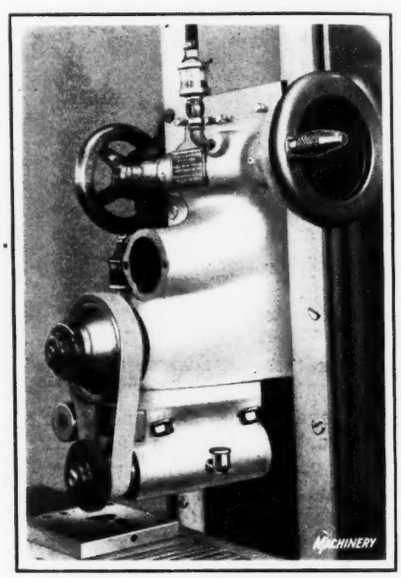
Fig. 2. Field of View through the Microscope

In turning the handwheel, worm-gearing is actuated to rotate the spindle of the dividing head. For making close adjustments, a small knob may be turned instead of the handwheel, this knob rotating a small bevel pinion which engages a bevel gear fastened along the inside of the handwheel rim. The spindle is locked in any desired setting by means of the binder handle at the right above the handwheel. The mechanism exerts equal pressure on both sides of the spindle so that it is not forced out of position. Simultaneously with the locking of the spindle, a ratchet mechanism is automatically brought into action to prevent rotation of the worm. The worm may be swung out of mesh with the worm-gear by operating the knob at the left of the binder handle. In addition to the main graduations on the glass dial, the spindle nose is graduated in degrees to enable rough indexing when the worm is out of mesh.

The head can be swiveled through over 90 degrees from the horizontal, and locked in any setting. Graduations on the swiveling member and a vernier scale on the stationary housing permit such settings to be made within an accuracy of 5 minutes. This dividing head is particularly suitable for use in manufacturing gages, master gears, ratchets, and indexing wheels for drilling, engraving, and milling machines; laying out and spotting jigs; measuring angles within close limits; indexing faces at given angles for milling, drilling, and grinding operations; checking cams; testing dividing heads used for operations performed on a quantity production basis; and for many other similar jobs. The weight of the device is approximately 165 pounds.

HIGH-SPEED ATTACHMENT FOR SURFACE GRINDING MACHINE

A high-speed attachment has been brought out by the Abrasive Machine Tool Co., East Providence, R. I., for application to its No. 3 surface grinding machine. This attachment has been developed to meet the requirements of certain classes of gage and tool work where small-diameter grinding wheels are essential. The wheel illustrated is 3 inches in diameter and 3/8 inch thick, and is mounted close to the bearing, but smaller wheels can be used, as well as extension wheel-arbors. Each wheel-arbor carries an integral pulley of the correct diameter to give the normal wheel velocity desired.

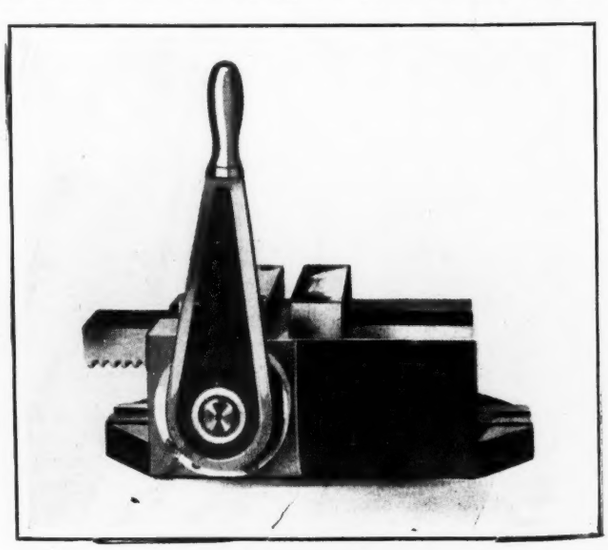


High-speed Surface Grinder Attachment

The wheel-spindle rotates on Norma ball bearings, which are protected from wheel dust. A No. 2 Morse taper hole is provided in the spindle. Power for driving the spindle is derived from a large pulley mounted on the main spindle in the wheel adapter. An endless canvas belt is employed, and an adjustable idler pulley, which is also equipped with Norma ball bearings, provides the desired belt tension. The attachment is applicable to machines now on the market.

QUICK-CLAMP MILLING VISE

The jaws of the milling vise shown in the accompanying illustration may be quickly opened or closed by operating the handle, which acts through a pinion and rack. After the jaws have been adjusted against the work, only a slight

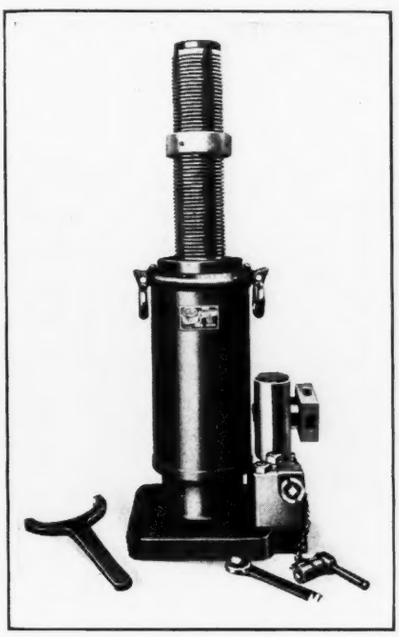


Quick-clamp Milling Vise

pressure need be applied on the handle to hold the work securely, and conversely, a slight pressure on the handle is sufficient to release the work. This vise has recently been placed on the market by the Universal Standard Sales Co., Woodward at Grand, Detroit, Mich.

WATSON-STILLMAN "HYDROSCREW" JACK

A hydraulic screw jack for which compactness, lightness, and safety features are claimed, has recently been introduced to the trade by the Watson-Stillman Co., Evening Post Building, 73 West St., New York City. There are only five working parts, and these as well as the valves, are all easily accessible for replacement. The oil filling is contained in a leakproof reservoir, and as no refilling is necessary, the danger of dirt getting into the system and clogging the valves is eliminated.

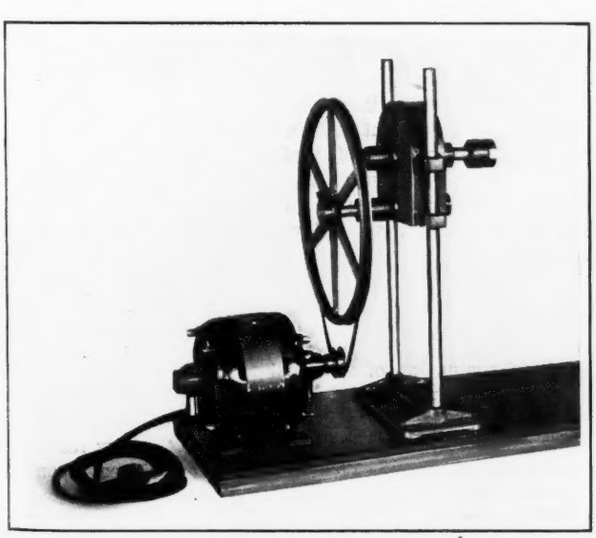


"Hydroscrew" Jack with Ram extended

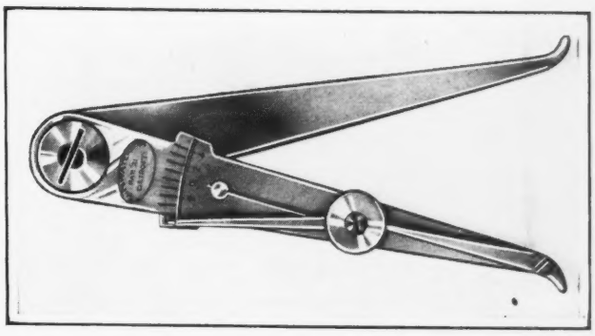
The ram is threaded, and provided with a safety nut to hold a load at any part of the lift. As the ram cap is a separate piece, it may be furnished in different lengths to give any height of jack from 20 1/2 to 42 inches. The jack is built in two capacities—for loads of from 20 to 40 tons, and from 40 to 75 tons, respectively. Patent applications have been filed for this device.

BOSTON GEAR WORKS SPEED REDUCER

A simple compact speed reducer intended for transmitting up to 1/4 horsepower has been placed on the market by the Boston Gear Works Sales Co., Norfolk Downs, Mass., for a large variety of applications. The reducer is mounted on two vertical posts and may be adjusted on these posts to increase or decrease the height. A speed reduction of 12 to 1 is obtainable through spur gears that are interchangeable.



Small Speed Reducer brought out by the Boston Gear Works Sales Co.



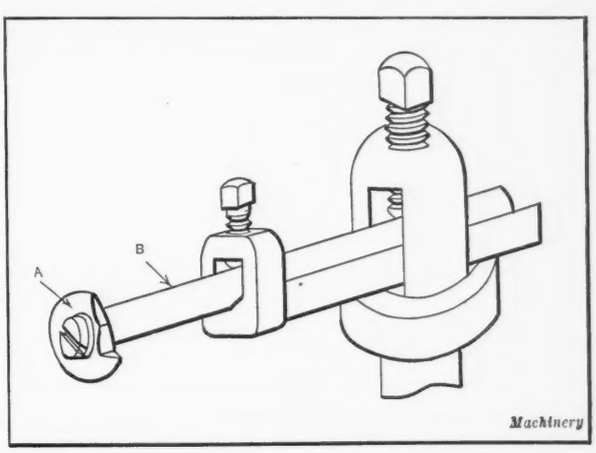
Grove Indicating Gage for determining Internal Dimensions of Parts

GROVE INDICATING GAGE

A Grove indicating gage designed for accurately measuring any internal dimension from about 1/4 to 4 inches, is shown in the accompanying illustration. This device has recently been placed on the market by J. M. Waterston, 427 Woodward Ave., Detroit, Mich. In appearance, the instrument resembles an inside caliper having one leg equipped with an indicating device. It is said that with a few minutes practice and a micrometer, any measurement within the capacity of the gage can be accurately made. All parts are hardened where necessary, and finished all over.

LEGGOTT CIRCULAR THREADING TOOL

Several interesting features are embodied in a circular tool for internal and external threading operations, which is being placed on the market by F. J. Leggott, 20 Cleveland



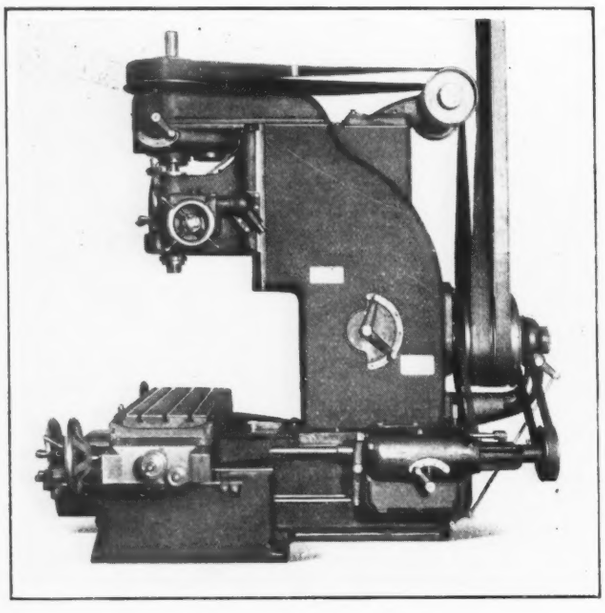
Leggott Circular Tool for cutting Internal or External Threads

St., Battle Creek, Mich. A large number of small flutes are broached in the hole of cutter *A*, and these engage corresponding flutes broached or milled on one end of bar *B*. The head of a small screw that is tightened into a tapped hole in the end of the bar, holds the cutter in place. With this construction, the cutter can be conveniently removed from the bar, ground, and replaced, without resetting the bar or tool-slide. Undue wear of the cutting point is obviated, because of the support offered by the body of the tool.

In setting up the tool for a job, the cutting point should be placed either on the center of the work or slightly below. It is mentioned that the cutter will not dip or "hog" into the work. By reversing the position of the cutter on the bar from that shown, chuck work can be threaded externally. The cutter is made from high-speed steel and ground after hardening.

BECKER DIE-SINKER

Increased size and weight of drop-forged die-blocks and similar large work that may be advantageously milled vertically has led the Reed-Prentice Corp., Worcester, Mass., to

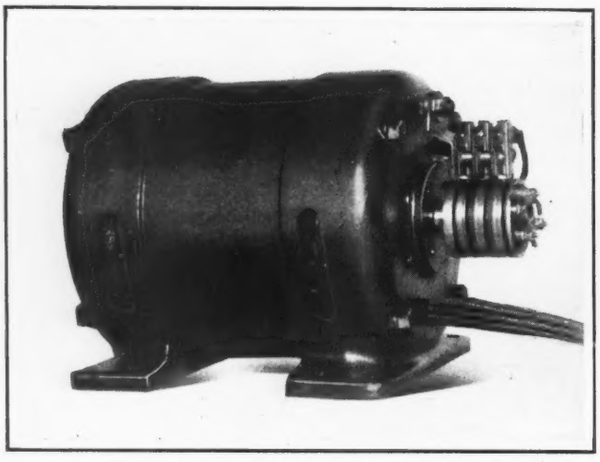


Becker Die-sinker or Vertical Milling Machine

develop a new model Becker No. 6 die-sinker or vertical milling machine. The new machine incorporates all the features of the former No. 6 machine. Some of the important specifications are as follows: Adjustment of the head on the column, 18 inches; adjustment of the spindle, 10 7/8 inches; working surface of the table, 72 by 20 inches; longitudinal travel of the table, 72 inches; cross travel of the table, 30 inches; height of table above the floor, 29 inches; minimum distance from spindle nose to table, 0, and maximum distance, 30 inches; depth of throat, 28 1/2 inches; and rate of cross and longitudinal rapid traverse, 125 inches per minute.

FORBES & MYERS FREQUENCY CHANGER

A frequency changer that permits the use of simple induction motors at higher than normal speeds is being introduced to the trade by Forbes & Myers, 178 Union St., Worcester, Mass. As is well known, an induction motor operating at 3600 revolutions per minute on 60-cycle current is a simple and reliable piece of apparatus with only a single moving part and no brushes or commutators. Induction motors are practical for speeds of 5400 and 7200 revolutions per minute, although for these speeds, the motors are not quite so simple as when operating at 3600 revolutions per minute. It is not practical to build induction motors for operating at more than 7200 revolutions per minute on 60-cycle current. The speed limitations mentioned apply only to 60-cycle current. The speed of any induction motor is proportional to the frequency, that is, if 90-cycle current is used, a standard 3600 revolution-per-minute motor runs at 5400 revolutions per minute. With 120-cycle current, it runs at 7200 revolutions per minute, and with 240-cycle current, at 14,400 revolutions per minute.

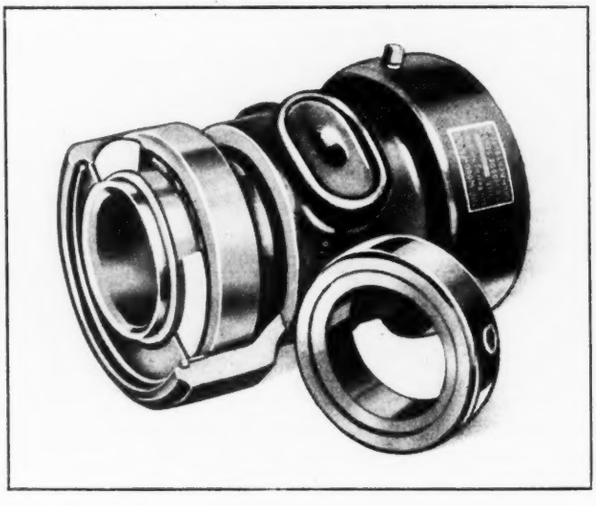


Forbes & Myers Frequency Changer for Use with Induction Motors

The frequency changer here illustrated gives 240 cycles when operated on 60-cycle current. It is intended for use with a standard two-speed motor for obtaining four speeds of 1800, 3600, 7200, and 14,400 revolutions per minute. The capacity of the frequency changer is 1/2 kilovolt-ampere, which is sufficient for 1/3 horsepower. It is the intention to build larger sizes of the frequency changer up to three kilovolt amperes for 2-horsepower motors. Mechanically, the frequency changer is identical with the familiar slip-ring induction motor, except that there is no projecting shaft for the drive. Electrically, the device has two sets of windings in the same slots, one to produce rotation and the other to change the frequency. A large variety of applications exist for this device.

WOOD-FAFNIR BALL-BEARING TRANSMISSION EQUIPMENT

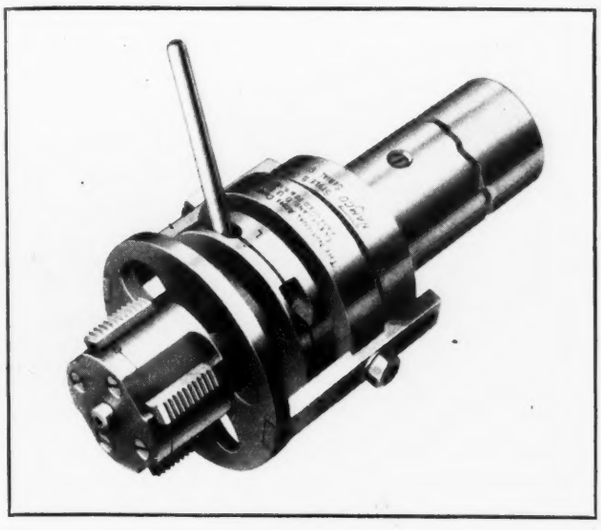
Fafnir ball bearings have now been adopted as standard for the entire line of power transmission equipment manufactured by the T. B. Wood Sons Co., Chambersburg, Pa. Housings are built in different styles with bosses designed to suit the different types of hanger frames made by this company, as well as all other hanger frames of standard makes. Therefore, plain or babbitted bearings can be replaced without removing hanger frames already installed. No adjustment is required of the Wood-Fafnir ball-bearing hanger box when it is mounted on the shaft. It is simply necessary to slide the box and two locking collars into place on the shaft and into the frame, draw up the frame bolts, and tighten the collars. The hanger box is dustproof and leakproof. Lubricant is supplied through two tapped holes fitted with standard pipe plugs, and need be replenished only about twice a year. In addition to ball-bearing hanger boxes, it is the purpose of the company to manufacture ball-bearing post hangers, pillow blocks, loose pulleys, friction clutches, etc.



Wood-Fafnir Ball-bearing Hanger Box

"NAMCO" COLLAPSING TAP

A collapsing tap of new design known as the style S has recently been put on the market by the National Acme Co., Cleveland, Ohio, to replace the older outside-trip type taps manufactured by this company. One of the new features of this tool is a recessed cup-like front plate of heavy construction, which is closely fitted over the body of the tap and held in place by screws. This plate adds to the rigidity of the tool and prevents the slotted portion of the body in which



"Namco" Collapsing Tap of New Design

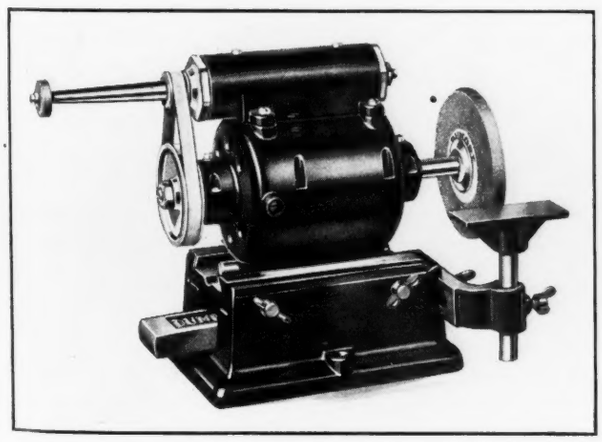
the chasers are held from springing or opening under pressure.

The new tap also has an improved method of size adjustment. The tool is adjusted for size with a few twists of a screwdriver, and can then be securely locked in the adjusted position. The adjusting collar is split along the periphery and contains two locking screws at right angles to the split. These screws are loosened a trifle to permit turning the two adjusting screws, and are then tightened to hold the adjusting screws securely in place. As in other "Namco" taps, the chasers are supported for their entire length while the thread is being cut. They collapse instantaneously as the core-piece is rotated into the collapsed position.

The tripping mechanism of this tool is actuated by a ring which, when it comes in contact with the work, withdraws the locking pin so that the chasers automatically collapse. The tool can easily be taken apart. Hobbed chasers of unusual length are used. For threading close to shoulders, overhanging chasers can be furnished. The style S tap is built in fifteen sizes, with a range for straight threads of from 7/8 to 7 1/8 inches.

BASE FOR "DUMORE" GRINDERS

A new base has been designed for use with the No. 2 "Dumore" grinders made by the Wisconsin Electric Co., 25 Sixteenth St., Racine, Wis. The accompanying illustration shows a grinder set in the base. The latter may be bolted to a work-bench, where it is always ready to receive the grinder when not in use on the lathe. The grinder is secured to the base by tightening two wing-screws. The bench grinder thus obtained is useful for small grinding operations, such as sharpening drills, cutters, etc., and for grinding various small parts.



"Dumore" Grinder and Base

PHILADELPHIA GEAR WORKS SPEED REDUCERS

Worm-gear speed reducing units are now built in various capacities up to 200 horsepower and with practically any ratio of reduction, by the Philadelphia Gear Works, Richmond and Tioga Sts., Philadelphia, Pa. The line includes units in which the worm is located either above or below the gear or in which the gear-shaft is vertical. The illustration shows the type A-X unit, which consists of a right-angle drive and is designed especially for conditions that require an overhung load, such as a pinion or sprocket, on the worm-gear shaft. A large diameter worm-gear shaft and roller

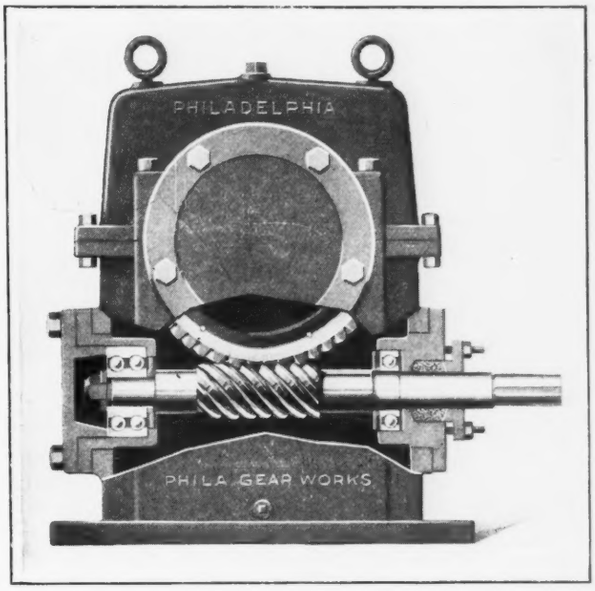


Fig. 1. Worm-gear Speed Reducing Unit built by the Philadelphia Gear Works

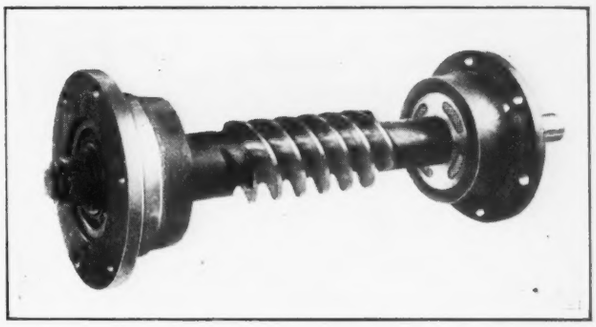


Fig. 2. Illustration showing Construction of the Oil Filter at Each End of the Worm-shaft

bearings on the driving end of the shaft provide for the overload condition.

The worm and shaft are integral and made from alloy steel. The threads are hardened, and ground to eliminate distortion and insure positive contact with the teeth of the worm-gear. The latter consists of a chilled cast-bronze rim, which is shrunk on and pinned to a cast-iron center. A new feature of these reducing units is an oil filter made of a fine-mesh bronze screen which is locked between two bronze plates at each end of the worm-shaft. This filter allows a constant circulation of oil to the bearings, and yet keeps out dirt and other foreign matter. The filter arrangement is illustrated in Fig. 2.

* * *

The automobile is becoming more commonly used than the telephone. Statistics show that there are more automobiles in this country today than telephones, by two or three millions. In Pennsylvania, for example, on December 31, 1925 there were 1,317,053 automobiles, and 1,123,851 telephones.

MEMBER OF AGMA

Gear Service

Spur—Bevel
Angular Bevel
Mitre—Worm
Internal—Spiral
Spiral Bevel
Intermittent—Herringbone
Racks—Special Gears

Made to Order

If a machine is worth building well it deserves good gears

ANY well built machine deserves good gears—gears of Brown & Sharpe quality.

Over fifty years of making the best possible gears for Brown & Sharpe machine tools, which have a high reputation for quality all over the world, have prepared the Brown & Sharpe Gear Department to handle your gear problems. The modern gear cutting and generating equipment, the grinding and modern hardening facilities of a great plant are all at hand for use in making gears exactly suited to your requirements.

The new "Gear Service" booklet tells about the Service, contains a considerable amount of useful gear data, and will help you present your problem when you wish to use the Service. Write for a copy.

BROWN & SHARPE

BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

For Good Gears—

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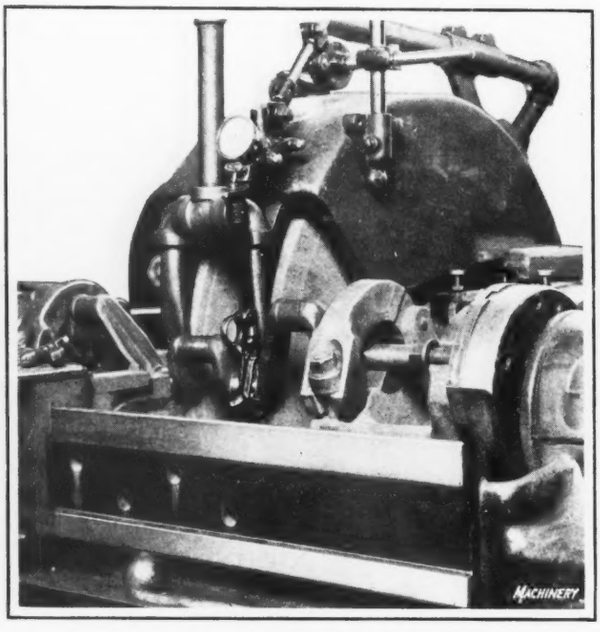
BROWN & SHARPE
GEAR SERVICE

TWIN-WHEEL GRINDING

Many parts having two or more diameters must be ground. Sometimes these diameters are equal, but usually they vary. Frequently the logical method of grinding them is to use two wheels spaced according to the location of the surfaces. This combining of cuts has resulted in large increases in production. Examples of twin-wheel grinding on Norton machines will be mentioned to illustrate the practical application of this method. The information that follows has been abstracted from an article by Raymond A. Cole, experimental



Machine equipped with Twin Wheels grinding Central Pair of Pins on Ford Crankshaft

engineer of the grinding machine division of the Norton Co., Worcester, Mass.

The twin-wheel grinding of steel knuckles is now common practice in large automotive plants. The general arrangement of the machine is the same as for ordinary wide-wheel grinding. For truing the grinding wheels, a multi-stop ring added to the wheel feed index, has two stops located so that the wheels will be trued to produce the correct diameters. In one plant, knuckles having large and small diameters of 1.312 inches and 0.8745 inch with a minus tolerance of 0.0005 inch, are ground at an average rate of 100 per hour, removing from 0.015 to 0.020 inch of stock.

Another part successfully ground by this method is a driving pinion. The diameters ground are 1.377 inches and 0.984 inch, respectively; the tolerance is 0.0005 inch; and the production, 45 per hour. Twin-wheel grinding may be applied to parts having a taper and a straight section, such as a distributor shaft. The diameter of the straight section is 0.249 inch by 1/4 inch long with a minus tolerance of 0.0005 inch, and the taper part has a small diameter of 0.377 inch, a length of 5/16 inch, a diameter tolerance of 0.004 inch, and a position tolerance of 0.010 inch. This part was originally ground on two machines which produced 118 shafts per hour. The twin-wheel method increased the production to 200 shafts per hour. For this operation, a wheel forming device is used instead of the multi-stop index. This device includes a form bar which insures truing the wheels in the correct relation to each other. The wheel truing device is mounted on the wheel guard and the diamond is traversed across the wheels by an electric motor. Water is directed on to the wheels inside of the guard.

Recent developments in twin-wheel grinding indicate that this method is applicable to crankshafts. The illustration shows a machine arranged for grinding the central pair of pins of Ford crankshafts. This machine is a regular Norton type B crankpin grinding machine with the pot chuck equipment regularly made for single-wheel grinding. A special wheel guard is required, and also a sleeve on which the two wheels and spacing collar are mounted. Only one two-bearing steadyrest located opposite the outer wheel is required. An indicating gage is mounted on the wheel guard and measures the inner pin. The finish grinding, removing 0.050 inch of stock from the diameter, is done in 50 seconds actual grinding time, or 1 1/2 minutes per shaft, including handling. The tolerance is 0.002 inch. The twin wheels average from 30 to 35 shafts per dressing. The former production rate, when using a single wheel and moving from one pin to the other, was 22 shafts per hour on the inner pins, or 2.7 minutes per shaft. Hence, the twin-wheel method increased production per machine about 80 per cent. For this operation, a lever feed is used that moves the wheel back about 3/4 inch in an 80-degree movement of the lever. This fast wheel-slide movement gives the extra clearance required for rapid handling.

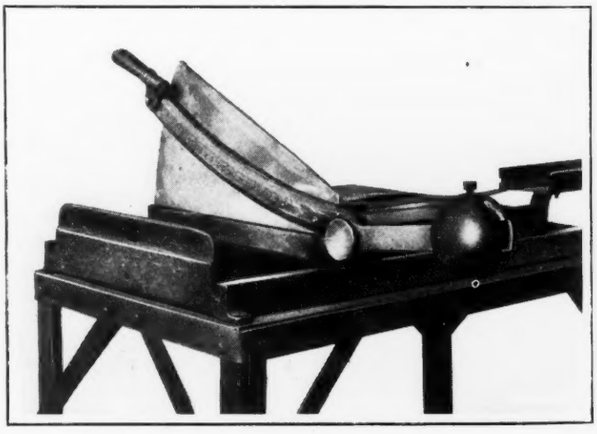
It is believed that important developments will be made in this twin-wheel method of grinding. While wheel maintenance costs may be slightly increased, this is more than offset by savings in labor cost. Standard machines can be used with little special equipment, although a machine having two independent wheel-slides, adjustable for spacing and positioning, is considered a logical development.

* * *

SAFETY GUARD FOR TRIMMING KNIFE

In using a hand-operated trimming knife, there is always the possibility of the operator or a passerby getting fingers or clothing caught by the knife on the down stroke. To prevent such accidents, an employe of the Baltimore, Md., Works of the General Electric Co., recently devised the safety guard shown in the illustration.

This guard consists merely of a circular sector of sheet metal, 1/8 inch thick, which is braced upright along the path of the back side of the knife. Right-angle brackets bent from 3/16- by 1-inch flat stock have the legs fastened to the guard and to the trimming board to hold the guard in position. The bottom of the guard is raised above the trimming board sufficiently to permit slipping the materials



Trimming Knife equipped with Simple Guard

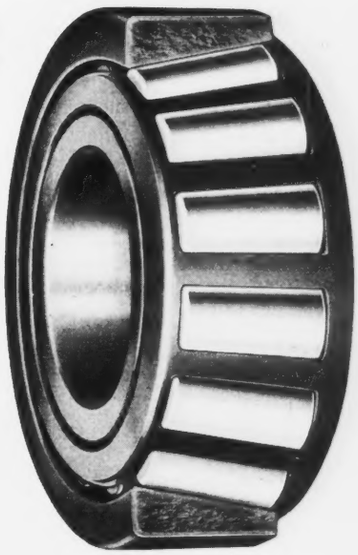
to be cut beneath the guard and under the knife. Accidents are eliminated because it is impossible to extend a hand or finger beneath the knife. Another advantage is that the trimming of light sheet metal with this equipment has been considerably accelerated since the installation of the guard.

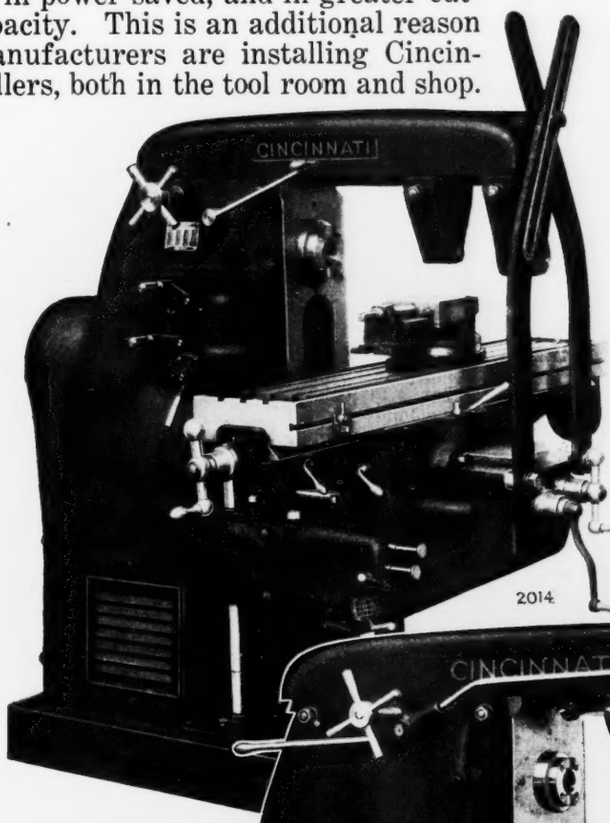
* * *

According to information obtained from the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., a Russian Commission is making a survey of the principal power plants in the United States. This hydro-electric commission has recently visited the Westinghouse Co. in Pittsburg, as well as numerous other manufacturing plants. The representatives of the United Soviet Socialist Republic stated that the proposed hydro-electric developments in Russia would require an expenditure of $75,000,000 within the near future.

FOR OVER A YEAR

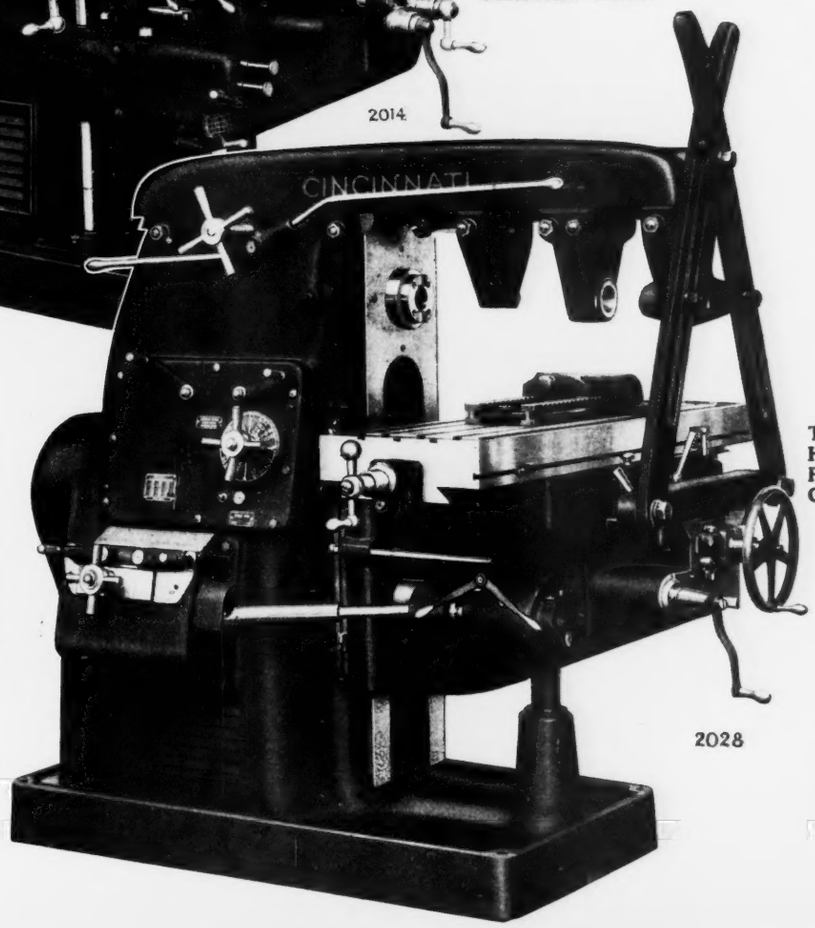
Tapered Roller Bearings have been standard equipment on Cincinnati Millers for over a year and have effected tremendous savings in power saved, and in greater cutting capacity. This is an additional reason why manufacturers are installing Cincinnati Millers, both in the tool room and shop.





The new M-Type Pyramid Column Cincinnati Miller.

2014



The new 2 and 3 High Power Type Pyramid Column Cincinnati Miller.

2028

Other Productive Features

Roller Bearings are but one of many features which make Cincinnati Millers easy to operate and highly productive. Our Book, "Service that Saves," shows over fifty illustrations of actual jobs where these features have been turned into actual dollar savings. Would you like to have a copy of this book?

The Cincinnati Milling Machine Co.

Cincinnati, Ohio

CINCINNATI

CINCINNATI MILLERS

TRADE NOTES

CADILLAC MACHINERY CO., Detroit, Mich., has removed its offices from the corner of Lafayette and Beaubien Sts. to the Peter Smith Heater Bldg., 6209 Hamilton Ave.

BOTWINIK BROS., Inc., 67 Water St., New Haven, Conn., announce the purchase of 1200 machine tools from a Hartford plant, which are now being sold and distributed by them.

LINCOLN ELECTRIC CO., Cleveland, Ohio, has appointed the Cleveland Tool & Supply Co., W. 6th St., Cleveland, local distributor for the full line of Lincoln motors and stable-arc welders.

GIBB WELDING MACHINES CO., Bay City, Mich., manufacturer of electric arc, spot, and seam welders, broke ground June 10 for an addition to its factory that will more than double the present floor space.

NATIONAL SUPPLY CO., Toledo, Ohio, announces that the company has opened a machine tool store and sales office at 211 McCrea St., Indianapolis, Ind. The Indianapolis branch will be operated as the ILLINOIS NATIONAL SUPPLY CO.

HOLLY MACHINE & TOOL CO., 202 S. Broad St., Holly, Mich., has recently been established for making tools, dies, jigs, and fixtures, and building special machinery. The shop of the new company has a floor space of about 1700 square feet.

CARR FASTENER CO., 31 Ames St., Cambridge, Mass., manufacturer of the "Dot" lubricator, has disposed of its interests in the automobile and commercial car field, in order to devote its efforts to the development of the industrial field.

STARK TOOL CO., Waltham, Mass., manufacturer of precision bench lathes, bench milling machines, and fine tools, has appointed the Harron, Rickard & McCone Co., of San Francisco and Los Angeles, distributor of Stark products in California, Arizona, and Nevada.

TIMKEN ROLLER BEARING CO., Canton, Ohio, has made plans to spend $1,500,000 in expanding its plant. Building plans have been completed, and the new units are to be finished by January 1, 1927. The construction program includes provision for enlarged laboratory and research facilities.

FENTON MACHINE TOOL & DIE CO., Fenton, Mich., announces that G. A. Olofsson, who has been vice-president of the company, is now president and general manager. The other officers of the company are Charles J. Olofsson, vice-president and production manager; J. A. Day, vice-president and sales manager; and Charles H. Lea, secretary and treasurer.

TOOL EQUIPMENT SALES CO., 18 S. Clinton St., Chicago, Ill., has been appointed exclusive factory agent for the Threadwell Tool Co., Greenfield, Mass. (manufacturer of carbon taps, dies, high-speed and ground thread taps, and small tools) for the territory comprising Illinois, Wisconsin, and the eastern part of Iowa. A complete stock of these tools will be carried in the Chicago store.

The Veteran's Association of the FARREL FOUNDRY & MACHINE CO., Ansonia, Conn., recently held its annual dinner, which was attended by ninety members. The association is composed of 121 employes, who have been with the company for twenty-five years or more. Only thirty-one of these are pensioners. The average length of service of the members of the association is thirty-three years.

TIMKEN ROLLER BEARING SERVICE & SALES CO., Canton, Ohio, announces that the Omaha branch office of the company, formerly located at 2524 Farnum St., has been moved to larger quarters at 2240 Douglas St. The management will continue to be under the direction of A. D. Hackim. The Los Angeles branch of the company has been moved from 1241 S. Hope St. to 1361 S. Figueroa St.

CECIL R. LAMBERT CO., INC., Detroit, Mich., specialist in the design, manufacture, and installation of conveying and handling equipment, has changed its name to MECHANICAL HANDLING SYSTEMS, INC. in order to identify the products and service with the name of the company. Additions are being made to the plant and personnel, but there are no changes in the ownership, management, or executive staff.

INDUSTRIAL MACHINE TOOL CO., INC., Fenton, Mich., has been organized to build special machinery, design and make dies for power press work, and rebuild machine tools. Almar Westman, who for the last ten years has been with the Fenton Machine Tool & Die Co., is secretary, treasurer, and general manager of the new company. His brother—Arnold Westman—H. Neil Palmer, and J. M. Edwards are associated with him in the business.

FLINT DIE & TOOL CO., 1016 Merrill St., Flint, Mich., specialist in drop-forging and sheet-metal dies and builder of special machine shop equipment, is adding a building to its present plant. The new building will be of modern steel and glass construction, with a floor space of 1700 square feet, adding approximately two-thirds to the present plant capacity. New equipment is also being added. F. J. Duesberry is general manager and superintendent, and R. C. Kleinpell, secretary and treasurer.

MERIT OIL EQUIPMENT CO., 6616 Morgan Ave., Cleveland, Ohio, manufacturer of "Demco" high-speed ball-bearing sensitive drills, announces that a machine of 7/8-inch capacity, with 8-inch overhang, has recently been added to this line of drills, and a complete line, with 12-inch overhang, will be placed on the market shortly. These new sizes embody the spindle construction characteristic of the 3/8-inch and 5/8-inch drills, in which the spindle bracket or sliding head is eliminated in order to secure rigidity and freedom from vibration.

H. B. CARLSON, formerly secretary and treasurer of the Mid-West Machine Tool & Supply Co., Davenport, Iowa, has disposed of his interest in that concern, and formed the CARLSON MACHINERY CO. Mr. Carlson's associates in the new company are R. R. Engelhart and H. R. Bartlett, vice-president and secretary, respectively of the Sieg Co., distributor of automotive equipment. The Carlson Machinery Co. will work in conjunction with the Sieg Co., covering the automotive equipment and industrial fields, and will carry a complete line of machine tools.

ALLOY CAST STEEL CO., Marion, Ohio, has recently been organized by John D. Owens, C. A. Owens, M. C. McNeil, H. J. Barnhart, Frank D. Glosser, Walter A. Dorsey, and E. J. Schoenlaub, all of Marion, Ohio. The company will manufacture electric steel castings in carbon, manganese, and other alloy steels. The electric steel foundry of the Fairbanks Steam Shovel Co. has been purchased, and is now being completely overhauled and enlarged to increase the capacity to 400 tons of steel castings per month. Extensive additions of foundry equipment are being installed.

REED-PRENTICE CO., Worcester, Mass., announces that the plan of reorganization of the company has been accepted by the stockholders, and in the future the firm will be known as the REED-PRENTICE CORPORATION. During the past year the active management has been strengthened by the addition of the following men: C. L. Stevens, vice-president in charge of operations; A. W. Schneider, works manager; and R. C. Blackinton, chief engineer. C. H. Carswell will be retained as treasurer, and F. W. McIntyre as vice-president in charge of sales. The board of directors remains the same.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa., is planning an extensive building program involving an expenditure of $5,525,000, for the expansion of facilities at its various plants and offices. New factory structures or office buildings are now in course of construction at East Pittsburg, Pa.; Mansfield, Ohio; Detroit, Mich.; St. Louis, Mo., East Springfield, Mass.; Sharon, Pa.; and Derry, Pa. The new general office building now nearing completion at the East Pittsburg works is eleven stories high, with a floor area of 165,000 square feet. The space is designed for the accommodation of 1800 employes.

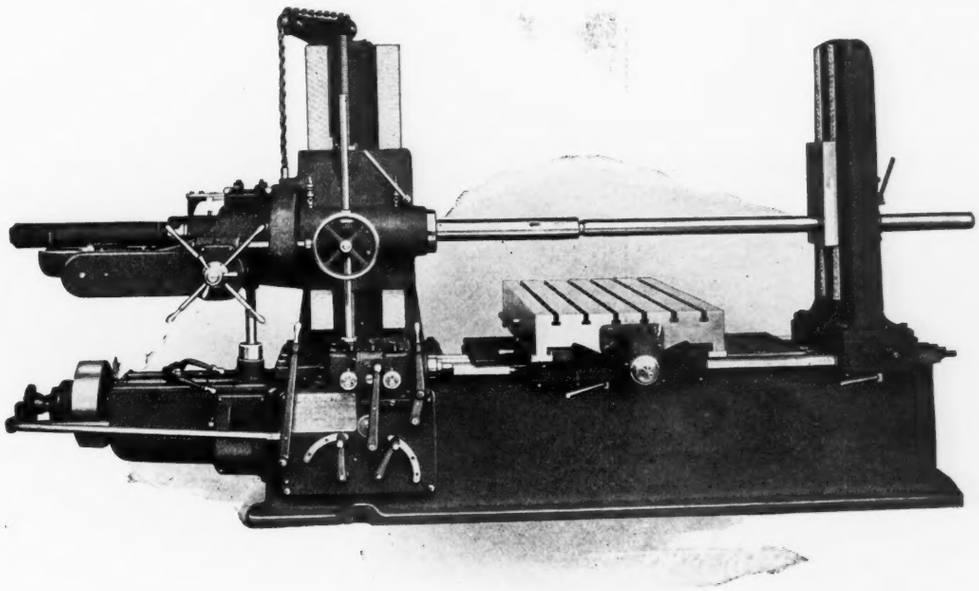
MECHANICS SUPPLY CO. has been organized by Thomas B. Finlay, 519 Miami Bank and Trust Building, Miami, Fla. Mr. Finlay has been representing a number of northern machine tool, metal, and supply manufacturers in the state of Florida for the last eight years. He now has associated with him Leslie R. Acton and J. R. A. Barnes. Mr. Acton was previously connected with the Studebaker Corporation as assistant treasurer, with the Flanders Motor Co. as treasurer, with the Maxwell Motor Co. as factory manager, and with the Redden Motor Truck Co. as treasurer. Mr. Barnes comes from London, England, and received technical training as a member of the Royal Naval Air Service. He has had six years sales experience in this country. The new company is to be incorporated and will establish branches in Jacksonville and Tampa to give sales representation to manufacturers.

ROCKFORD MILLING MACHINE CO. and ROCKFORD TOOL CO., Rockford, Ill., announce that the two organizations have been consolidated under the name of the SUNDSTRAND MACHINE TOOL CO. It is believed that with a combination of the manufacturing, engineering, and financial resources of the two companies, the new organization will be in a better position than ever before to serve the industry. The two concerns have, since their inception, been under one management but operating in different plants. Considerable additional space will be provided at the present plant of the Rockford Milling Machine Co., and the machinery and equipment of the Rockford Tool Co. will be transferred to that plant. H. L. Olson, who has been connected with the organizations from the beginning, will be secretary and general manager of the new company. G. D. Sundstrand will continue to serve as inventor and chief designer, and will have as his assistant, C. A. Sundstrand.

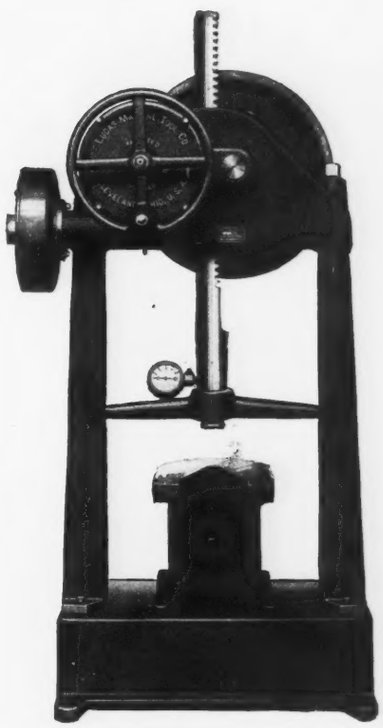
Modern Equipment Cuts Costs

It is sometimes astonishing to discover the obvious. One of our customers was astonished to discover that the job he had always been obliged to send to one of his neighbors who had an open side planer could easily be done on his new

"Precision" BORING DRILLING & Milling Machine



There is no more "power" in a Press (or other machine) than is put into it. If the power is put in by hand, it is only one man power. In the



LUCAS
Power Forcing Press

the power is put in by belt or motor, but it has all the sensitiveness and delicacy of control of the best hand press, with the necessary power for heavy work.

THE LUCAS MACHINE TOOL CO., Cleveland, Ohio, U. S. A.

FOREIGN AGENTS: Alfred Herbert Ltd., Coventry, Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Oslo, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo. Ing. M Kocian & G. Nedela, Prague.

PERSONALS

H. E. GILMORE has been made manager of the St. Louis branch of the Timken Roller Bearing Service & Sales Co., Canton, Ohio.

GLEN TRESLAR has been transferred from the position of manager of the Buffalo office of the Van Dorn Electric Tool Co., Cleveland, Ohio, to a similar capacity in the Chicago office.

L. GERALD FIRTH has been appointed general manager of the Firth-Sterling Steel Co., McKeesport, Pa., and R. S. STEVICK has been made works manager. Mr. Firth was formerly works manager, and Mr. Stevick, assistant works manager.

COLONEL CHARLES CLIFTON, chairman of the board of the Pierce Arrow Motor Car Co., Buffalo, N. Y., was re-elected to his twenty-second term as president of the National Automobile Chamber of Commerce at the annual meeting of that body held in New York on June 3.

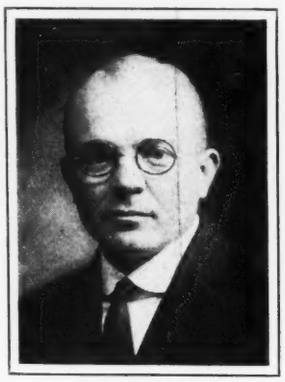
L. W. ROLFE has been appointed sales manager of the Taylor Electric Truck Co., Troy, N. Y., manufacturer of electric railway car trucks, railway car springs, and springs for heavy vehicles. Mr. Rolfe formerly served in the same capacity with the Simmonds Machine Co. of Albany, N. Y.

A. MILTON BUCK has joined the sales force of the Bridgeport Brass Co., Bridgeport, Conn. Mr. Buck will make his headquarters in Washington, and his territory will comprise Washington, D. C., and the states of Maryland, Virginia, and West Virginia. He will specialize on sales of Bridgeport-Keating flush valves and "Plumrite" brass pipe.

R. F. SHAW, sales representative of the Kearney & Trecker Corporation, Milwaukee, Wis., who has been making his headquarters in Grand Rapids, Mich., has been transferred to the Chicago office. Mr. Shaw will continue to have charge of the western Michigan territory of the company, and in addition, a portion of the city of Chicago and northern Illinois.

S. H. J. MISTARY, 249 Eruchshaw Bldg., Hornby Road, Fort, Bombay, India, announces that he has opened an agency and will be interested in getting in touch with tool and hardware manufacturers interested in distribution in India. Mr. Mistary has been engaged in the selling of tools and hardware in India since 1907 for well-known English and American firms.

FRANCIS T. WEST, who has been the western manager of the Watson-Stillman Co., 73 West St., New York City, for the last twenty-five years, with headquarters in Chicago, has resigned, and is succeeded by J. F. COYNE. Mr. Coyne's headquarters will be at 549 W. Washington Blvd., Chicago. JAMES T. LEE and JOHN O. CLARK will assist Mr. Coyne in handling Watson-Stillman hydraulic machinery.



Roscoe Seybold

Bearing Service and Sales Co., Canton, Ohio, to district manager of sales, industrial division for the Milwaukee territory. Mr. Curtis will work with R. W. BALLENTINE, who has previously handled this territory. S. M. WECKSTEIN succeeds Mr. Curtis as industrial equipment engineer. G. W. RICHARDS and A. R. SPICACCI have been appointed assistant industrial equipment engineers to assist Mr. Weckstein.

PROFESSOR T. MCLEAN JASPER, formerly of the University of Illinois, has been placed in charge of the research activities of the A. O. Smith Corporation, Milwaukee, Wis., manufacturer of automobile frames. Professor Jasper is a recognized authority on the fatigue of metals, for the last five years having had charge of that branch of the University of Illinois' laboratories engaged in this form of research. He has written numerous papers on this subject, which have been presented before engineering societies both in America and England.

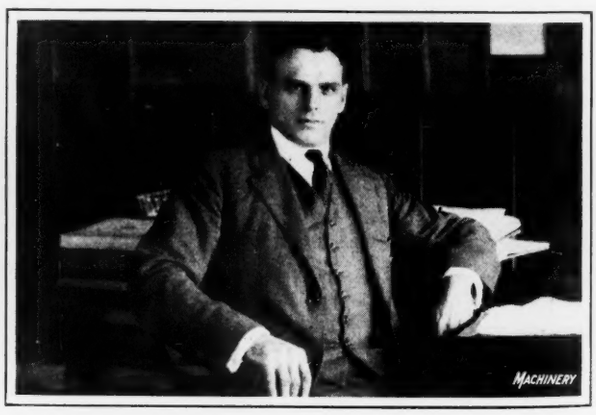
ROSCOE SEYBOLD has been appointed assistant to the vice-president and general manager of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mr. Seybold has been with the Westinghouse Co. since 1907. He was born in Rockville, Ind., and graduated from Purdue University in 1907, with the degree of Bachelor of Science in electrical engineering. He then came to East Pittsburg where he entered the college graduate apprentice course of the Westinghouse Electric & Mfg. Co. Since completing his apprenticeship, he has held various positions in the business departments, during the last few years having been in the sales department.

GEORGE E. THOMAS has resumed his former connection with the Gisholt Machine Co., Madison, Wis., as New England representative, with headquarters at 80 Allendale Road, Hartford, Conn., and FRANK M. NELSON has resumed his former position with the Gisholt service department, with headquarters in Worcester, Mass. JOHN H. NEBEL, who for several years has been a member of the sales department in Madison, Wis., is now representative of the company for the eastern half of Wisconsin, with headquarters in Milwaukee.

FRANCIS HODGKINSON, for many years chief engineer of the South Philadelphia Works of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed consulting mechanical engineer for the entire organization. The position of chief engineer of the South Philadelphia Works has been discontinued and the position of manager of engineering has been substituted. A. D. HUNT, for many years a member of the engineering staffs of the Westinghouse organization, will fill the new position of manager of engineering.

Mr. Hodgkinson was born in England and educated at the Royal Naval School at New Cross, London, from which

Francis Hodgkinson



A. D. Hunt

CHARLES C. PHELPS, 473 Getty Ave., Paterson, N. J., and CHARLES J. SCHMID, his associate, have been appointed metropolitan New York and northern New Jersey representatives for the Uehling Instrument Co., Paterson, N. J., the Williams Gauge Co., Pittsburg, Pa., the Combustion Control Division of the A. W. Cash Co., Decatur, Ill., and the National Boiler Protector Co. of Dayton, Ohio. Mr. Phelps retains his former connection with the Uehling Instrument Co. as treasurer.

G. W. CURTIS has been promoted from the position of industrial equipment engineer with the Timken Roller

he graduated in 1882. Upon leaving the Navy, he became engineer for the Telephone Co. and Electric Light Co. at Lima, Peru. After his return to England, he joined C. A. Parsons & Co. and when, in 1896, the Westinghouse Machine Co. acquired the American rights for the manufacture of the Parsons type turbines, Mr. Hodgkinson became connected with that company, which subsequently became the turbine building section of the Westinghouse Electric & Mfg. Co. Slightly more than a year ago, Mr. Hodgkinson was awarded the Elliot Cresson Gold Medal by the Franklin Institute in recognition of his scientific achievements.

HEAVY-DUTY

with Arbor Integral

Type No. 11 Blade for Wetmore Adjustable Heavy-duty Reamer.

For heavy-duty jobs—where unusual strength and ruggedness are needed, and *speed,* too—use the Wetmore Adjustable Heavy-Duty Reamer (Type No. 11) with arbor integral.

This is a six blade reamer, ranging in size from 1″ to 2 15/16″ inclusive. Larger sizes made special to order. Wide range of adjustment provides for wear and regrinding, so that this reamer with its original blades actually outlasts several solid, non-adjustable reamers. The 1/8″ projection of the blades over the end of the reamer body allows the chips to fall off ahead of the reamer, so they do not clog up along cutting edge of blades.

Here are four features that make these Wetmore Heavy-duty Reamers, as well as other types of Wetmore reamers, first choice in so many plants:

1 Adjustment to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made.

2 Solid alloy steel body, heat-treated, guaranteed against breakage.

3 Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring while backing out. Shearing effect of blades increases life of cutting edge.

4 No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.

Send for Catalog No. 26, showing full line of Wetmore Adjustable Reamers — and new, reduced prices.

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WETMORE ADJUSTABLE REAMERS

"THE BETTER REAMER"

Mr. Hunt was born in Tarrytown, N. Y., and graduated from Cornell University in 1905 with the degree of mechanical engineer. In the same year, he joined Westinghouse, Church, Kerr & Co. in an engineering capacity, and in September, 1919, joined the Westinghouse Electric & Mfg. Co., being assigned to the South Philadelphia Works in the marine service section. In 1920 he was appointed manager of steam service.

FRANK A. SCOTT, president of the Warner & Swasey Co., Cleveland, Ohio, was presented with the degree of Doctor of Laws by the Western Reserve University on June 16, "for life-long pursuit of culture, for the application of the powers of a constructive mind to problems municipal, state, and national, and for the benefits secured through unselfish public service."

JUSTUS H. SCHWACKE, formerly president and a director of William Sellers & Co., Inc., Philadelphia, Pa., resigned on May 31, and ALEXANDER SELLERS was elected president on June 1. Mr. Schwacke had been with the company continuously since 1862; he was elected secretary when the company was incorporated in 1886, director in 1902, manager in 1905, and president in 1922. He was active in the National Metal Trades Association, the National Founders Association, and the Metal Manufacturers Association of Philadelphia. Mr. Sellers has been with the company since 1896, and has served as vice-president since 1905.

A. E. HITCHNER, an executive of the East Pittsburg Works of the Westinghouse Electric & Mfg. Co., has been promoted to the managership of the company's Los Angeles office to fill the post made vacant by the resignation of K. E. VAN KURAN. Mr. Hitchner joined the Westinghouse organization in 1909, and was assigned to general industrial sales work in the Philadelphia office. In 1912 he was placed in charge of anthracite mining sales projects, and in 1919 he was transferred to the headquarters of the company at East Pittsburg as assistant to the manager of the industrial department, his work having to do specifically with mining and oil industries.

LELAND RUSSELL VAN WERT, for the last six years a member of the faculty of the Harvard Engineering School, has been appointed assistant professor in metallurgy at the Carnegie Institute of Technology, Pittsburg, Pa. Professor van Wert graduated from Union College, in Schenectady, N. Y., in 1916, and later was a graduate student in metallurgy and metallography at Yale University, Massachusetts Institute of Technology, and the School of Mines and Engineering at the University of Arizona. His experience has included positions as metallurgical engineer with the Ordnance Department of the United States Army, research engineer with the Dorr Co., New York City, and metallographist with the Remington-Arms Union Metallic Cartridge Co., Bridgeport, Conn. Since 1920, he has been instructor in metallurgy at Harvard University.

OBITUARY

URI T. HUNGERFORD, chairman of the board of directors of the U. T. Hungerford Brass & Copper Co., New York City, died at his home in New York on June 16 in his eighty-fifth year. Mr. Hungerford was born in Torrington, Conn., on December 14, 1841. He came from old New England stock, and was one of twelve children. The family has been intimately associated with the brass industry for many years, his father, John Hungerford, having built the first brass mill in Torrington, Conn., in 1834. In 1865 Mr. Hungerford attended the West Point Academy, but terminated his studies after two years to go into business. He then became associated with Wallace & Sons, Brass & Copper Rolling Mills, of Ansonia, Conn., acting as New York representative and manager until 1895, when he established the U. T. Hungerford Brass & Copper Co.

HANDBOOK OF AUTOMOTIVE STANDARDS

More than 500 standards and recommended practices that have been approved by the Society of Automotive Engineers are now for the first time published in a single bound book. This is the S.A.E. Handbook which is being distributed to the society's members and to any others who have use for it from the headquarters of the society at 29 W. 39th St., New York. Revised editions are to be issued every six months, after the standards committee has acted on recommendations for new and revised standards at the annual and semi-annual meetings. The book is 7 1/2 by 4 1/2 by 3/4 inch, and contains more than 600 pages. It is bound in flexible leather covers and contains all the specifications, standards, and recommended practices representing the cumulative results of the cooperative standardization efforts of the engineers from the beginning of automotive standardization work twenty years ago. These include a great number of drawings, tables, charts, and forms, and much elucidating text. The contents are grouped systematically into sections and indexed.

An index is also included that lists only the products of suppliers who have filed with the society certificates specifying the parts and materials they are in position to furnish in accordance with the standards. This is in conformity with the certification plan of the U. S. Bureau of Standards.

Only those specifications are standardized that promote interchangeability, eliminate unnecessary varieties, facilitate production or servicing, promote safety, or advance uniformity in testing, nomenclature, or operating requirements. The use of these standards in the industry has been reliably estimated to have resulted in a saving of at least 15 per cent in the total annual retail cost of American automotive products.

COMING EVENTS

JULY 1-SEPTEMBER 15—International Exhibition for Inland Navigation and Utilization of Hydraulic Power, at Basle, Switzerland. For further information apply to Organizing Secretary, International Exhibition, Basle V, Switzerland, or to the Swiss Federal Railroads, 241 Fifth Ave., New York City.

SEPTEMBER 2-3—Aeronautic meeting of the Society of Automotive Engineers at the Bellevue-Stratford Hotel, Philadelphia, Pa. Coker F. Clarkson, 29 W. 39th St., New York City, secretary.

SEPTEMBER 7-10—Machine tool exhibition in the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. H. R. Westcott, chairman, 400 Temple St., New Haven, Conn.

SEPTEMBER 20-24—Eighth annual convention and exposition of the American Society for Steel Treating to be held at the Municipal Pier, Chicago, Ill. W. H. Eisenman, secretary, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 21-23—Production meeting of the Society of Automotive Engineers to be held at the Hotel Sherman, Chicago, Ill., simultaneously with the exposition of machine tools and heat-treating equipment sponsored by the American Society for Steel Treating. Coker F. Clarkson, 29 W. 39th St., New York City, secretary.

SEPTEMBER 27-OCTOBER 2—Annual convention of the American Foundrymen's Association and second international foundry congress in Detroit, Mich. In conjunction with these conventions there will be held an international exposition of foundry and machine shop equipment and supplies. C. E. Hoyt, secretary-treasurer, 140 S. Dearborn St., Chicago, Ill.

OCTOBER 2-10—Southern exposition to be held in the New Madison Square Garden, Eighth Ave. and 49th St., New York City. W. G. Sirrine, president of the exposition, New Madison Square Garden, New York City.

NOVEMBER 16-18—Transportation and service meeting of the Society of Automotive Engineers at the Copley-Plaza Hotel, Boston, Mass. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

NOVEMBER 16-19—Eighth annual fall meeting of the American Welding Society in conjunction with the International Welding and Cutting Exposition, Inc., at the Broadway Auditorium, Buffalo, N. Y.

DECEMBER 6-11—Fifth national exposition of power and mechanical engineering at the Grand Central Palace, New York City. Managers of the exposition: Charles F. Roth and Fred W. Payne of the International Exposition Co., Grand Central Palace, New York City.

NEW BOOKS AND PAMPHLETS

BLACKSMITHING. By R. W. Selvidge and J. M. Allton. 156 pages, 6 by 9 inches. Published by the Manual Arts Press, Peoria, Ill. Price, $1.20.

This text-book is designed for use in school shops and farm shops, as well as for the blacksmith who desires to extend his knowledge and increase his skill. It contains a set of instruction sheets which cover thirty-eight unit operations in the blacksmithing trade. Information is given concerning solders, fluxes, materials, tools, etc.

MATHEMATICS AND THE MACHINIST'S JOB. By Frank Cushman. 226 pages, 5 by 7 inches. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price, $1.75, net.

This book has been prepared for the use of machinists, machinists' apprentices, and students of machine shop practice in vocational schools. It is intended to be particularly adapted to the needs of part-time and evening trade extension classes, as well as to serve as a text-book for related shop mathematics for day trade classes and apprentice schools. Part I gives simple explanations of the common types of problems dealt with in the shop. Part II contains a course on lines, surfaces, and solids, and other general trade mathematics of value to machinists.

NEW CATALOGUES AND CIRCULARS

STEEL TIES. Bethlehem Steel Co., Bethlehem, Pa. Catalogue descriptive of Bethlehem steel ties for mines and industrial track.

SOLDERING IRONS. General Electric Co., Schenectady, N. Y. Circular illustrating and describing the new line of GE electric soldering irons.

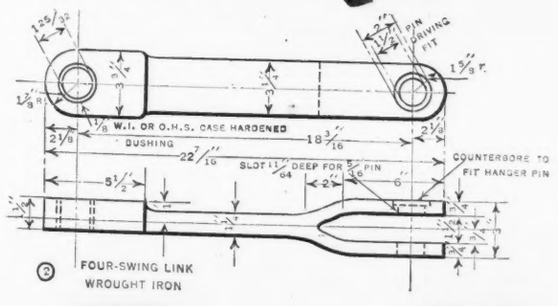
AIR FILTERS. Drying Systems, Inc., 1800 Foster Ave., Chicago, Ill. Circular descriptive of the Phoenix electrically operated air filter for industrial use.

Range, Capacity and Dependability for the R. R. Forge Shop

This 2″ New Model Ajax Upsetter at the Long Island R.R. Shops at Morris Park has replaced one of our Original Model machines in use there since 1901.

Though the old machine had rendered excellent service for a score of years, modern efficiency and capacity demands made necessary its replacement with a thoroughly up-to-date machine. Quite naturally a New Model Ajax was the machine installed as its wide range, unusual capacity and dependability make it most practical for the all-round demands of the modern Railroad Forge Shop.

The increased die dimensions, twin gear drive and drop lock stop motion device are features which deserve your investigation.



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VENTILATING FANS. Aircraft Mfg. Co., Inc., 901 Harries Bldg., Dayton, Ohio. Circular descriptive of the "Fan-O-Plane"—a ventilating fan of new design.

GRINDING WHEELS. Abrasive Co., Bridesburg, Philadelphia, Pa. Catalogue containing a complete description of "Borolon" and "Electrolon" grinding wheels and polishing grain.

ELECTRIC ELEVATOR EQUIPMENT. General Electric Co., Schenectady, N. Y. Circulars illustrating installations of electric elevator equipment in office buildings throughout the country.

TAPPING MACHINES. Frew Machine Co., 124 W. Venango St., Philadelphia, Pa. Circular illustrating and describing the No. 1 Frew automatic tapper, which is designed for production tapping.

CONDENSERS. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Bulletin L-20286, containing data on static condensers for power factor correction on motor circuits of 220, 440, and 550 volts.

DIESEL ENGINES. Foos Gas Engine Co., Springfield, Ohio. Bulletin 707, descriptive of the outstanding features of the Type L Diesel engine, which has a power range of from 50 to 475 horsepower.

ELECTRIC RESISTANCE STARTERS. Allen-Bradley Co., 286 Greenfield Ave., Milwaukee, Wis. Bulletin 600, descriptive of alternating-current resistance starters for standard squirrel-cage motors.

TAPS. Commercial Tool Co., Plymouth Bldg., 2026 E. 22nd St., Cleveland, Ohio. Circular illustrating Victor collapsible taps, solid adjustable taps, and receding-chaser taps made by the Landis Machine Co.

MILLING MACHINES. Kearney & Trecker Corporation, Milwaukee, Wis. Circular announcing a new No. 4 milling machine. The leaflet gives specifications and describes important features of the design.

ELECTRIC MELTING POTS. Hynes & Cox Electric Corporation, Albany, N. Y. Circular announcing a new Hynes-Cox electric melting pot for lead, tin, solder, etc., having a capacity for 15 pounds of lead.

WELDING AND CUTTING EQUIPMENT. Alexander Milburn Co., 1416 W. Baltimore St., Baltimore, Md. Miniature catalogue of Milburn welding and cutting apparatus, illustrating the complete line of Milburn equipment.

HOBS AND MILLING CUTTERS. Illinois Tool Works, 2501 N. Keeler Ave., Chicago, Ill. (Sales agent, The Commercial Tool Co., 2026 E. 22nd St., Cleveland, Ohio.) Leaflet illustrating Illinois hobs and milling cutters.

LATHE AND DRILL CHUCKS. Cushman Chuck Co., Hartford, Conn. Catalogue 44, of lathe and drill chucks, containing the revised prices for Cushman chucks and their replacement parts that became effective May 17.

HONING MACHINES. Barnes Drill Co., 814 Chestnut St., Rockford, Ill. Circular illustrating and describing the Barnes No. 214 multiple-cylinder and the No. 212 single-spindle hydraulically reciprocated honing machines.

DILATOMETERS. Stanley P. Rockwell Co., 66 Trumbull St., Hartford, Conn. Bulletin 2605, descriptive of the application of the Rockwell dilatometer in heat-treating tools, dies, taps, gears, etc., by the Volcrit method.

MECHANICAL SLEDGE. Chambersburg Engineering Co., Chambersburg, Pa. Advance bulletin 213, illustrating the Chambersburg mechanical sledge, which is adapted for use in all types of forge shops, foundries, repair shops, etc.

GRINDING MACHINES. Norton Co., Worcester, Mass. Pamphlet entitled "Grinding in the Railroad Repair Shops," illustrating machines used for railroad shop work and giving machine and production data on different railway parts.

ROLLER BEARINGS. Rollway Bearing Co., Inc., Syracuse, N. Y. Catalogue 3A, containing tables of dimensions and load ratings for the Rollway line of roller bearings, which includes a wide range of sizes in both radial and thrust types.

WIRE-FORMING MACHINERY. Baird Machine Co., Bridgeport, Conn. Circular showing examples of wire products produced on Baird wire-forming machines. Data relating to the smallest and the largest sizes of machines are included.

POWER FACTOR CORRECTION. Wagner Electric Corporation, St. Louis, Mo. Bulletin 146 entitled "Power Factor Correction by the Consumer," relating the experience of the American Gas & Electric Co. in correcting power factor with Fynn-Weichsel motors.

CHUCKS. Skinner Chuck Co., New Britain, Conn. Condensed catalogue of lathe, drill, and planer chucks and vises, showing chucks of both light and heavy patterns, screw-operated and air-operated. The catalogue gives dimensions and prices of the various sizes and styles.

BALL BEARINGS. Marlin-Rockwell Corporation, Gurney Ball Bearing Division, Jamestown, N. Y. Catalogue giving dimensions, load ratings, and price lists of the M-R-C thrust bearings, which have just been added to the line of annular ball bearings made by this concern.

CHAIN DRIVES. Boston Gear Works Sales Co., Norfolk Downs, Mass. Pamphlet C2-26, covering the line of industrial chain drives made by this company. Suggestions on the selection of chain drives are given, and dimensions and prices are tabulated for the various sizes of chains and sprockets.

DRINKING FOUNTAINS. Century Brass Works, Inc., Belleville, Ill. Catalogue M (1926), superseding all previous catalogues and folders. This pamphlet contains descriptive matter and prices covering the line of sanitary drinking fountains and plumbing specialties made by this concern.

ENGINEERING AND PLUMBING SPECIALTIES. Mueller Steam Specialty Co., Inc., 502 W. 126th St., New York City. Catalogue 22, illustrating and describing pressure reducing and regulating valves, strainers, boiler controls, steam traps, pump governors, air traps, liquid level controllers, etc.

METAL WARE. Rome Mfg. Co., Rome, N. Y. Catalogue M, giving data on copper and aluminum utensils; steel and brass covered tubing; drawn metal specialties; and die-pressed forgings. Pamphlet giving tables of approximate weight of brazed, butted, and welded joint steel tubing, as well as hot- and cold-rolled steel tubing and brass tubing.

AIR-OPERATED CHUCKS. Logansport Machine Co., 529 Market St., Logansport, Ind. Catalogue R-22, covering the complete line of air-operated devices made by this company, including air-operated two- and three-jaw chucks, collet chucks, expanding mandrels, and special chucks, special air-operated milling and drilling fixtures for automatic machines, and air cylinders.

INTERNAL GRINDING MACHINES. Heald Machine Co., 16 New Bond St., Worcester, Mass. Instruction book on the Heald No. 72 "Size-matic" internal grinding machine, giving general information on the construction and operation of this machine, as well as detailed setting-up instructions. The large number of illustrations make the instruction easily understood.

PNEUMATIC RIVETERS. Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Bulletin entitled "Transportation Depends on Riveting," showing examples of the use of Hanna riveters in the railway field, riveting locomotives and cars. Another example illustrated, on which Hanna riveters were used, is the steel bridge connecting the north and south boulevard systems of Chicago.

WIRE ROPE. American Cable Co., 215 N. Michigan Ave., Chicago, Ill. Handbook for wire rope users, containing information on how to measure wire rope; how to uncoil or unreel wire rope; how to make an endless splice; how to seize rope properly; how to socket wire rope; and how to care for wire rope both in and out of service, as well as other material relating to the use of wire rope.

CHAIN DRIVES FOR MACHINE TOOLS. Link-Belt Co., 300 W. Pershing Road, Chicago, Ill. Book No. 812, entitled "Machine Tool Drives," illustrating and describing a large number of applications of Link-Belt silent chain drives on machine tools, including lathes, drilling machines, broaching machines, automatics, gear-hobbers, saws, presses, grinders, turret lathes, shapers, boring machines, etc.

MEASURING WIRES AND PRECISION GAGES. Van Keuren Co., 12 Copeland St., Watertown, Boston 72, Mass. (Sales agent, The Commercial Tool Co., 2026 E. 22nd St., Cleveland, Ohio.) Circular treating of the three-wire system of measuring National or U. S. standard threads, and containing suggestions regarding the use of Van Keuren measuring wires. Circular descriptive of Van Keuren precision gages.

TURRET LATHES. Gisholt Machine Co., Madison, Wis. Booklets descriptive of the Gisholt Nos. 3L and 4L full-swing side carriage turret lathes, equipped with fixed center turret and cross-feed turret, respectively. A detailed description of these machines is given, and the principal dimensions are listed. Illustrations of the tooling employed on different classes of work are shown, as well as standard tools for chucking work.

PNEUMATIC TOOLS FOR RAILWAY SHOPS. Ingersoll-Rand Co., 11 Broadway, New York City. Handbook covering the principal uses of pneumatic tools in railway shops. The booklet contains over 140 illustrations of actual installations in different shops, showing air tools used in locomotive boiler repair work, in making locomotive tender repairs, in erection and machine shops, in steel car repairs, in wood work on composite cars and wooden cars, in passenger car work, and in foundries.

SHEET METAL WORKING TOOLS AND MACHINES. Peck, Stow & Wilcox Co., Southington, Conn. Catalogue covering the complete line of "Pexto" machines and tools for sheet-metal work, including shears, punches, foot presses, power presses, folders, formers and benders, grooving machines, crimping and beading machines, seaming and flanging machines, hand tools, roofing tools, elbow-making equipment, etc. A section of the catalogue contains information on equipping for and teaching sheet metal working. The book is supplied with an index and a list of code words for convenience in ordering.

GEARS AND SPEED REDUCERS. Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill. General catalogue 2000, entitled "Gear Problems," containing comprehensive data covering the Foote Bros. line of gears, as well as spur and worm gear speed reducers and special machinery. In addition to the catalogue data presented, a large amount of information of interest to users and designers of gears and conveying equipment is contained in the engineering section of the book. As an aid to quick reference, the book is indexed by subjects in the upper page corners, and has a complete cross-reference index in the back.

TURRET LATHES. Warner & Swasey Co., Cleveland, Ohio. Final booklet, entitled "Chuck Work (Section II)," in the series on "Modern Tooling Methods for Turret Lathes." This book continues the discussion of chucking work that was begun in Book II and describes two types of chucking equipment now available for the Warner & Swasey No. 4 and No. 6 machines. The principles of increasing production are illustrated by typical chucking lay-outs, and the individual design of the tooling equipment is discussed. The book ends with "The Final Question"—a definite comparison of the value and the cost of universal tooling equipment.